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THE AMERICAN GAS LIGHT JOURNAL

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[OFFICIAL NOTICE.]

Appointment of a Committee of Reception by the American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION, OFFICE OF SECRETARY, PROVIDENCE, R. I., June 5th, 1893.

The following named members of this Association are appointed and respectfully requested to serve as a Committee of Reception, whose duty shall be to call upon all foreign gas engineers visiting our country during the continuance of the World's Fair at Chicago, whose names and addresses may be obtained, and to introduce them to other members of our profession, see that they obtain permits to visit the neighboring gas works and other objects of interest, and generally to make their stay in New York as pleasant as possible, and when they leave for Chicago, to give them letters of introduction to the Committee of Arrangements at Chicago: Messrs. Wm. Henry White (chairman), Eugene Vanderpool, William H. Bradley, Fred. S. Benson, William R. Beal, Jos. R. Thomas, Thos. F. Rowland, Jr., Fred. W. Floyd and Oscar Weber.

The Guild of Gas Managers and the Society of Gas Lighting are respectfully requested to co-operate with this committee in extending hospitality to our visiting professional brethren.

A. E. BOARDMAN, President.
A. B. SLATER, JR., Secretary.

[OFFICIAL NOTICE.]

The American Gas Light Association's Greeting to European Gas Engineers.

AMERICAN GAS LIGHT ASSOCIATION, OFFICE OF SECRETARY, PROVIDENCE, R. I., June 5th, 1893.

To the European Gas Engineers—Greeting: The American Gas Light Association will hold its 21st annual convention in the city of Chicago, beginning on the date of Wednesday, October 18th, 1893. It would give the members of the Association great pleasure to meet there as many of the European gas engineers and managers as can make it convenient to be in attendance at the World's Fair at that time. It is suggested that all contemplating visiting the Fair arrange their visits so as to be in Chicago, if possible, at the time of this convention, when they will be most cordially welcomed by the Association and invited to attend the sittings of the body and participate in its discussions of papers presented.

Those engineers who cannot conveniently visit the World's Fair at that time, but must choose some other date, are respectfully requested to send their names and addresses, as soon as they arrive in America, to the AMERICAN GAS LIGHT JOURNAL, No. 32 Pine street, New York City, so that a committee from the Association may be made aware of their presence, and when they may be met, so that they may form the acquaintance of their professional brethren in this country and be made to feel less like a "stranger in a strange land."

A. E. BOARDMAN, President.
A. B. SLATER, JR., Secretary.

BRIEFLY TOLD.

THE WORLD'S FAIR MEETING OF THE AMERICAN ASSOCIATION.—The issuance of a circular letter some days ago by Secretary Slater, of the American Gas Light Association, brings positively before us the fact that the coming of age meeting of that body is close at hand. It is rather appropriate that its 21st anniversary should be celebrated mid the scenes of the World's Fair; but is decidedly saddening that those scenes are not to have more of the color and fire of gas in them. We know that lamenting over that which should be but which is not is neither consoling nor profitable, so we will not dwell longer on the indifference, shall we say, of the industry at the time when the call for the money necessary to arrange and maintain a suitable display of gas and its possibilities at the Fair was made. No; it is best to accept the situation (even if the acceptance is flavored by the bitter pill of regret) without audible demur. The Secretary's circular (which bears date of the 7th inst.), does not deal

distinctly with any of the preparations now in hand for the actual carrying on of the meeting, but rather has to do with revising and perfecting the membership list, a request that those intending to be in Chicago with the Association next October forward their statement to that effect well in advance to the Secretary, a hint or two in connection with the published volumes of the proceedings, an intimation that it is not likely any particular concession over the ruling rates for railway travel will be obtainable, and a reminder that those who seek admission to membership *must* have their applications made to the Secretary not later than October 7th. These hints are all timely, and it goes without saying that the wise will let the Secretary know at their earliest convenience of their intention to be on the ground. Remember that from now on the attendance at the Fair is bound to increase; also, that mid-October will be the period when the crowding of the city will be most marked. So, if all are to be taken care of comfortably, the executives of the Association can accomplish all the more in that direction through being enabled to make arrangements with the Windy City bonifaces *now*. It is to be hoped that the Secretary's other timely hints will receive that close attention which their importance in the domestic economy of the Association demands. One other paragraph in the circular demands especial mention, and that is the notification that "hereafter all queries accepted for the Question Box will be published in advance of the meeting;" the object being to give those interested in the several conundrums propounded an opportunity to discuss the same intelligently and at length. We favor this proposal greatly; for it is an unwelcome certainty that the contents of the Question Box have often been slurred or slighted, and only for the reason that the questions were of a nature complex enough to call for previous study or thought to the end that they might be rightly answered. The Secretary requests that matter for the Question Box be forwarded prior to the 5th prox. In the meantime we may say that the meeting bids fair to be most successful; and President Boardman and Secretary Slater are working indefatigably to that end.

THE PROPOSED GAS FRANCHISE FOR KANSAS CITY, MO.—The Mayor of Kansas City, who rejoices in the decidedly suggestive name of Cowherd, is most open in his avowal to corral the Kansas City Gas Light and Coke Company; nor will he listen to anything like reason in respect of naming a gas rate for that city which will be fair to the consumers and just to the gas suppliers. Owing to the time conditions that gave it corporate life, the Company finds it necessary to ask for a renewal of the franchise under which it operates, and, after a conference with the authorities, agreed to, in consideration of a franchise covering a period of 30 years, supply gas at the rate of $1.50 per 1,000 cubic feet, until such time as the annual sendout amounted to 250,000,000. When that quantity was exceeded, other concessions were to be made, the price to be governed by the sendout reached. If we mistake not, the minimum rate on maximum sendout was put at $1 per 1,000 and 600,000,000 annually, respectively. The initial rate of $1.50 on an output of 250,000,000 looks to be fair all around, when the conditions of gas manufacture and supply at Kansas City are analyzed and given their due weight; but Mayor Cowherd will have none of this. He wants the cattle "gathered together" in a single sweep; for his ultimatum is a rate "in the neighborhood of $1 per 1,000," no matter what the output is or may be. We believe the extreme latitude allowed by the Mayor respecting "the neighborhood" of his suggested dollar rate does not exceed $1.15, which figure is an absurd one, remembering that the output of the Company for the current year will likely not exceed 225,000,000 cubic feet. It may be that the proprietors of the Company will ultimately see their way clear towards offering an initial rate of $1.35 per 1,000 on the 250,000,000 basis, but beyond this it is clearly impossible to go, Mayor Cowherd to the contrary notwithstanding.

MR. REINKE'S ENRICHED SEWER GAS.—An extraordinary defense was recently interposed by a man named Reinke, who was before a police court of Cleveland, O., charged by the Peoples Gas Light Company of that city with having bye-passed one of its meters and thus obtained fraudulently a supply of gas in his premises, No. 7 Monroe street. When arraigned he explained to the judge that the situation was like this: "In my cellar I have an airtight tank, filled with a certain chemical preparation, to which is attached a pump. With this pump I pump gas from the sewer into the airtight tank. It passes through the chemicals, then through the pipes around the meter and to the floors above. When I touch a match to it the gas burns brightly and furnishes me with splendid illumination." This scheme out-Harrises anything which that celebrated process manipulator ever put on the market; but it was seemingly as unsuccessful, since the sewer gas man was held for further examination.

The Gas Engine as Applied to Electric Light Work.

[A paper read by Mr. George A. Farwell, of Waukesha, Wis., before the Madison (Wis.) Meeting of the Northwestern Electrical Association.]

By request of your President I consented to prepare a short paper, to be read at this meeting, on "The Gas Engine as Applied to Electric Light Work;" but I do not expect to present for your consideration anything that is not comparatively well known, as the subject has repeatedly been discussed in technical papers.

I shall not refer to the advantages or disadvantages of the different types of gas engines in use, but simply give you some details of my experience with the one I have had running for the past year in the station of the Waukesha (Wis.) Electric Light Company.

This is a 100-horse power, two cylinder, Otto gas engine. The cylinders are horizontal, one directly above the other. The connecting rod from the upper piston takes hold of the crank-pin, while the connecting rod from the lower piston is attached to the upper connecting rod, some distance back of the pin. The supply valves to the cylinders are disc valves, opening inwardly, and are held in their seats by light spiral springs.

The exhaust valves are flat valves, which are opened by a cam. The governor regulates the speed of the engine, and controls the admission of gas to the cylinders. There is a gas bag between the meter and the engine to insure an even pressure.

The gas pipe from the meter to the gas bag is 4 inches in diameter, and from the gas bag to the engine 3 inches in diameter. The gas is ignited by an electric spark produced from a 4 cell Edison Lalande battery. A water jacket surrounds the cylinders to prevent overheating, and there is an exhaust pipe for each cylinder.

Naturally the motion of the engine would be somewhat unsteady, on account of the force of the explosions, but this disadvantage is entirely overcome by a heavy pulley and fly-wheel on the engine, and by the use of a countershaft carrying a heavy balance wheel. The engine runs at 160 revolutions per minute, and the balance wheel 690. This insures steady motion at the dynamos.

The speed of the engine can be increased or decreased at will by manipulation of the governor.

While the engine is running the amount of gas it consumes is regulated by the governor for the varying load it carries.

It is a simple matter to record correctly actual expense in generating power for running dynamos with a gas engine. I have a countershaft, to which are belted a 100 horse power engine, one 100-horse power steam engine, one 80 light arc dynamo, one 75 light arc dynamo, and one 600-light incandescent dynamo. By the use of clutch pulleys I can run any one, or any two of the dynamos with either engine, or I can run any two of the dynamos with either engine, and the other dynamo with the other engine; or I can run the three dynamos with both engines at the same time.

I generally start up with the gas engine running the commercial arc dynamo and the incandescent dynamo. When it is time to turn on the street lights I start the steam engine, switch the commercial arc dynamo and the incandescent dynamo off of the gas engine on to the steam engine, and the street lights on to the gas engine. I have too much load for either one of my engines to carry it all, but when it is so that one engine can carry it, I make the gas engine do the work.

It is a well known fact that when illuminating gas is burned in a gas engine to drive a dynamo very much more light can be produced than can be produced by burning the same quantity of gas in burners in the usual way.

For instance, 4 gas burners burning 5 feet per hour, and 18 candle gas, will give light equal to 72 candles. The same amount of gas burned in a gas engine will produce an electric arc light of 2,000 candle power.

An average of six different tests, made by myself during the month of June, to ascertain the cost of gas consumed by a 100 horse power Otto gas engine, per horse power per hour, resulted as follows:

To arrive at the cost of the gas used by a gas engine when it is located at the gas works, one wonld have to ascertain just what the gas at his own works, and at a particular point in its manufacture, costs; then, none of the cost of distribution should be counted. In this instance, to carry the example to completion, I have figured the cost at 50 cents per 1,000 cubic feet.

The amount of gas consumed in 10 hours' run of gas engine, driving 53 arc lights of 2,000 candle power each, on a 9½ mile circuit, was 10,920 cubic feet, or 1,092 cubic feet per hour, or 20.6 cubic feet of gas for each lamp, which, at a cost of 50 cents per 1,000 cubic feet, is .0103 per lamp per hour, or per horse power per hour. Figuring shafting,

dynamo, line and lamps, I found that the whole, taken together, represented practically 53 horse power.

In another test, where I ran 36 arc lights and 300 incandescents, representing 69 horse power, the consumption of gas was 1,400 cubic feet per hour, or 20.3 cubic feet per horse per hour, or .0115.

In a test where I ran 36 arcs and 425 incandescents, representing 80 horse power, the consumption of gas was 1,600 cubic feet per hour, or 20 cubic feet per horse power per hour, or 0.1. These tests show that as the load increases the cost per horse power decreases.

Following is a report of two 50-horse power Otto gas engines, made in October, 1889, in the State of Wisconsin :

Facts and Figures Concerning One Month's Run of Two Otto Gas Engines, 65-Horse Power, Driving 52 Arc Lamps, 2,000-Candle Power each, 11 Miles Circuit.

October, 1889 ; total time, 180 hours and 55 minutes ; total gas consumption, 264,000 cubic feet. Gas consumption per lamp hour, 23.53 cubic feet. During that month 4.84 cubic feet of gas were made from each pound of Youghiogheny coal; thus the coal consumption per lamp hour would be $\frac{23.53}{4.84} = 4.8$ lbs. of coal.

Cost.

To produce 264,000 cubic feet of gas consumed in engines, there were required 54,545 lbs., or 27.272 tons of coal, at $3.15 =		$85 86
There were obtained from this amount of coal, as bye products:		
Coke, 33 bushels per ton = 899 bushels of 40 lbs.; 50 per cent. used as fuel, leaves 450 bushels, at 10 cents	$45 00	
Tar, 13 gallons per ton = 351 gallons, at 10 cents	35 10	80 10
Leaves total cost for fuel to drive 52 arc lamps for the entire month of October		$5 76

There was no extra expense for labor on account of the additional amount of gas produced for the gas engine, nor on account of operating them. The handling of this fuel occasioned no extra expense. With steam power, not only coal must be handled at special outlay, but also ash. The amount of the fuel already less than that required by steam power, has its cost materially reduced, and in some cases almost entirely offset by revenues from coke and tar. Where no revenues whatever are obtained from bye-products, *it will still pay to use gas power*, and for this reason :

Because the handling of fuel can be done in gas house without extra expense, but will call for extra labor when consigned to boiler house.

The following is a quotation from *Practical Electricity*,* published at Boston :

"At the 18th annual meeting of the New England Association of Gas Engineers, held in Boston, February 15 and 16, a series of questions were propounded for the consideration of members. One of these questions reads as follows—

" How will the gas engine work to supply power for an electric light plant? How does it compare in economy with a steam engine?

" Mr. A. M. Norton, of Nashua, N. H.—We have a 15-horse power Otto engine. From the moment we started it the lights burned very steadily, and have all the time. We have 10 lights on it. They are the steadiest arc lights that I ever saw. Probably it will not carry 10 lights as cheaply as a smaller engine with the same number of lights ; but it now runs 10 full arc lights, and uses 275 feet of gas per hour with the lights all on.

" Mr. C. F. Prichard, of Lynn, Mass.—I have paid considerable attention to the running of the Otto gas engine in a general way, but not for producing electric light. It struck me, as Mr. Norton stated, that the steadiness and reliability of the engine for running the electric light lamp has been thoroughly demonstrated. Mr. Norton states that he uses 275 feet of gas to run 10 lights an hour ; 275 feet would be 11 cents per hour—that is, it would be 1.1 cents per horse power per hour, assuming it takes one horse power per light. I think it would be difficult to find a steam engine running so small a plant which would work down to 4 pounds of coal per horse power hour, considering the conditions under which they run. Considering the coal that is used to bank the fires to keep them, and the quantity used in starting the fire, I think it is doubtful if the average of the electric light plants will run on less than 6 pounds of coal per horse power; but, for the sake of comparing with Mr. Norton's figures, let us take 4 pounds of coal per horse power per hour. Figuring that out at $4.50 per ton, we have the result of 1 cent per horse power per hour. Mr. Norton figures the gas at 40 cents per thousand, bringing it down to 1.1, which gives us .1 of a cent difference in just this simple case, and we have still to allow for the cost of water for the boiler, and for the labor of firing. The actual expense, as I believe they figure it, is 1.1 cent. per hour. In that case we have the cost identical, whether he runs with the gas engine and uses gas at first cost, or uses a steam engine with coal at $4.50 per ton. This shows to me that we are able, even at the present time, with a gas engine to compete with the steam engine for power ; and it seems to me, with increased resources, and the possibility of cheap fuel gas to supply our gas engines in the future, the steam engine has got to go for running electric light plants."

The discussion, which was continued at some length, I will not repeat.

It is worth the while of electrical engineers to look carefully into the question of large gas engines. Too much attention is being given to small details of electrical construction. It does not matter so much whether a dynamo gives 95 or 96 per cent. of efficiency, if there is a consumption of 20 pounds of coal per delivered electrical horse power hour. The brain work spent in securing the odd 1 per cent. in the dynamo would be more profitably invested in studying the behavior of various engines and boilers under the very abnormal conditions that hold in central stations. The question of idle boilers is a serious one. An engine at half load takes too much steam, but it is little good cutting this steam down if the boiler burns almost as much coal when it supplies less steam. Central station conditions are about as bad for boilers and engines as they possibly can be. Now, consider the case of the gas engine. Allowing that no one but gas companies would think of working electric light stations with coal gas, yet when supplied with water gas, or producer gas, the gas engine of to-day can compete with the steam engines at full load.

Under the conditions that prevail in central stations the gas engine has the advantage, in that when the engine stops the consumption of fuel stops also. There is no water to boil before starting, and no ashes to remove. Gas engines are less expensive than steam engines and boilers, and can be started and stopped without trouble when wanted.

They take less room, make no smoke, and are cheaper to run. Larger gas engines are being turned out with water gas plants and with gas producers. The time will probably come when gas engines will displace steam engines altogether in electric light stations.

*See American Gas Light Journal, Vol. 38, issue of March 16, 1893, p. 175.

Notes on the Prepayment Meter.

[A paper read before the North British Association of Gas Managers, by Mr. Geo. Keillor.]

As requested, I have prepared a few notes on the prepayment meter system, with the view of bringing the subject before you for discussion, but having had these meters in use for only about a year, I am afraid my short experience may be of little service, and so perhaps part of the valuable time at your disposal may be taken up unnecessarily. However, I beg to ask your kind forbearance for a few minutes.

This prepayment adaptation to the ordinary meter may be said with truth to be another step in the right direction. The system has already been rewarded with very great success, and it is rapidly finding favor among the poorer class of gas consumers. By this arrangement " a long-felt want " has been supplied. It is indeed a friend to the poor, and completely eclipses the old but true saying, " Short accounts mak lang friends."

I may here state that, at a meeting of my Directors held in March, 1892, I had a meter fitted up in the Secretary's office, by which it was shown how a pennyworth of gas could be bought and afterwards consumed. The Chairman expressed great satisfaction with the arrangement, and said he considered the coin meter to be the best invention he had yet seen for the poorer class of consumers, and to keep gas companies from making bad debts.

A short time after this 12 of these meters were ordered, so that I might experiment with them. These have now been thoroughly tested, and I am pleased to inform you the results were very satisfactory, and also that my anticipations formed with regard to the quantity of gas consumed, and the corresponding pennies in cash boxes, have been more than realized. I may, however, state that I had very grave doubts as to the meters possibly being troublesome to consumers, by the light going out at a busy moment, or that the slot arrangement might get out of order, and so pass a greater quantity of gas to the consumer than the money value in the cash box ; but in practice I find these apparent doubts and inconveniences entirely disappear. The consumer gets so well acquainted with the working of the meter, and the time his one

two, three or more pennies' worth will last, that he likes the system, and is put to no inconvenience whatever. On one occasion only we had to take in a meter which ceased to give light, the cause of which was found to be a penny stuck in the slot—the penny having been by some youth hammered into an irregular shape—which necessitated our taking the cover of the meter off. Makers should therefore enlarge the slot a little, as it is not necessary for it to be the exact size to admit the coin.

When ordering these 12 meters, it was not my intention at first to press for new consumers; and, of course, we had no applications for them. But it occurred to me that, rather than give them to new consumers to commence with, I might select 12 ordinary small consumers, who were all more or less in arrear, and consequently would have been more than likely to have their gas supply cut off. Rather than do this, and very probably lose all, I used some liberty with these defaulters, by way of making an experiment with the prepayment meter. Most of them were glad to get such a meter, while several others absolutely refused to allow their meters to be shifted, and declared, if such were done, they would commence using oil. Notwithstanding these remonstrances, I insisted on having the meters put in; and, strange to say, on making our periodical calls three months after, we did not find oil in use, neither did we find the cash boxes of the meters by any means empty. On the contrary, nearly double the quantity of gas had been paid for than would have been consumed by the ordinary meter, and this without a word of complaint. One consumer remarked: "I doubt you have given me a stick to break your own back with. You will not get me overcharged this time, as you did the three corresponding months last year. I have only put in a few pennies each time I needed light; and that was no oftener than I could help." However, on reading the meter, the inspector considered that, if the pennies in the box agreed with the number of feet registered, the gas company will have no reason to complain; and the consumer also was apparently well satisfied. The result was 12s. in the box as compared with 7s. 6d. the corresponding months complained of.

To show how accurately the arrangement works out, compared with the ordinary index reading, I have noted down the results of the first two quarters. From Nov. 1 to Feb. 1, the 12 meters indicated a total consumption of 13,200 feet. This, at the rate of 10 feet a penny, or 8s. 4d. per 1,000 feet, makes a sum of £5 10s. value registered; while the money taken from the meter cash boxes was £5 10s. 5d.—being 5d. more cash than the number of feet registered amounted to. This extra 5d. was accounted for as having passed through the slot, to pay for gas not yet consumed. The average per consumer was thus 9s. 2d.; and this with consumers of one burner each. Again, the same 12 meters for the quarter from Feb. 1 to May 15, indicated a total consumption of 11,200 feet, being £4 13s. 4d.; while the cash in the meter boxes was £4 13s. 11d. This time, therefore, there was 7d. more than the amount charged for the gas consumed.

Our ordinary price is 6s. 8d. for lighting, and 4s. 2d per 1,000 feet for heating and cooking, etc.; but to cover the extra cost of the meter and meter rent, we set our prepayment meters at 10 feet a penny—being 8s. 4d. per 1,000 cubic feet, or 1s. 8d. above the ordinary price. The makers sent out some time ago a circular letter in which they say, regarding their prepayment meters: "Gas so supplied is generally sold at a slightly higher price than is charged for it through the ordinary meter, so as to cover interest and other charges; but this is a small matter compared with the advantage to the consumer. The increased rate should include meter rental, to obviate extra charges, which are unpopular with the consumer, who has, in this case, only to place a penny in the slot and procure a certain quantity of gas." I have merely given these few details to show how accurately the measuring of a pennyworth of gas at a time compares with the index reading at the end of three months. Also that there is an increase of gas consumed, to the extent of about 33 per cent. over the ordinary meter, and that these consumers are much more satisfied.

I have now only to say that gas companies and corporations ought to give notice, by advertising or otherwise, to all proprietors, architects and builders, that, when erecting new buildings or when altering old ones, the gas company will supply automatic meters to be fitted into all workmen's houses. Also that, when architects specify the plumbing and gas fitting work, it should be specially mentioned in the specification, to the effect that a meter and suitable gas bracket will be fitted up complete, by the gasfitter, after which the gas company will send an official to instruct the tenants as to the working of these prepayment meters. In Nairn, among other buildings, I did the architectural work in connection with a block of houses where there are 12 tenants. In the specification of plumbing and gasfitting work, it was specified that one automatic meter must be fitted complete into each house—the meter to be supplied by the gas company, and fitted in by the contractor. I know very well that none of these 12 tenants had any intention of using gas when they rented these houses, and most of them, in fact, informed me they did not want the meter placed. But, on discussing the matter with them, I said it was part of the gasfitter's duty to fix these meters; and that they had better allow the meter to be put in in the ordinary way. I also took the opportunity of saying that perhaps the first time they were out of oil, or it may be a lamp chimney got broken, they might for a change put the value of the new lamp chimney in the slot of the meter; and by so doing they would come to see how handy and ready the gas is when obtained in this way, compared with oil. I remarked that ultimately I expected to see an ornament on each of their shelves, in the shape of an oil lamp.

Well, whether or not you believe the system to be just as successful as I do—a great deal of which success depends on gas managers themselves—there is one thing certain, that the cleanliness, readiness and easy purchase of the light by this system will go on finding favor among the poorer classes; and I most certainly recommend the system wherever gas is used. And, further (more especially in small towns), I would say should this class of consumer not get the opportunity to use gas by this system, we shall be guilty of what I am afraid we too often are—"standing in our own light."

Discussion.

Mr. W. A. Valon (Ramsgate) said he had not anticipated that he would be asked to make a few remarks about the prepayment system of meters. He agreed with their friend who had read the paper, that there was not the slightest doubt that they were moving in the direction of introducing more of these things day by day. Some companies had gone very largely into the question. He had himself worked on the same principle as the author of the paper, but not with the identical meter. In his opinion, it was better to put a stop on the index, for a certain amount of money in advance. He had used these "penny in-the-slot" meters; but he did not think they gave him the satisfaction which their friend had described. He found, first of all, that the instruments themselves were somewhat expensive; and besides they were liable to derangement. Of course, these were all things that might be overcome; and he had no doubt they would be. The President, in his address, mentioned a certain town where there were 10,000 of these meters employed. He did not know if it was the same town he referred to; but he knew a place where there were something over 7,000, and he understood that they were so far unreliable that an agreement had to be made with the consumer that not the number of pennies in the box should be the indication of the quantity of gas consumed, but the index itself—it being found that every quarter about 15 per cent. of these meters were wrong. That was to say, that there had to be an adjustment of accounts in about 1,000 out of 7,000 cases. This was a serious drawback. Some had to pay more, by finding that the amount in the box did not agree with the index; and some had paid too much, and this had to be returned. But he thought there was another point which was equally important in connection with the prepayment meter, if he was not going outside of the range of the paper, and that was that, in cases where fittings did not exist in houses, it was all very well to ask builders and contractors to put pipes in. Sometimes they would not, and sometimes they did; but he thought it was there that companies might come in and assist poorer people to burn gas. It was not a very serious matter. It cost about £3 on an average for a house of £12 to £30 a year rental—that was to say, that for £3,000 they could secure 1,000 consumers. He did not believe there was any gas company which would not pay £3,000 of invested capital to secure this number of consumers. He certainly must think, seeing that he took this meter in hand some years ago, that it was a step in the right direction. He did not know that it altogether depended upon meters of that class; but he did say that shorter payments, arrangements with consumers to collect their accounts oftener, the fitting up of houses, and the giving to that part of the public who had not hitherto been able to use gas the opportunity of burning it under easy conditions, were directions in which all companies and corporations ought to move.

Mr. J. Hepworth (Carlisle) said it was very good of the President to give him the opportunity of speaking at that meeting; but he was sorry his experience did not enable him to add anything of much value to the discussion. He agreed with the observation of the author, that they did stand in their own light whenever they failed to take the opportunity of furthering the consumption of gas. He happened to be gas engineer in a town where the consumption was very extensive—he meant where the number of consumers was greater than perhaps it was in most other places in proportion to its population; and they never felt the necessity

of adopting the prepayment system. But he quite believed in everything that had been said in its favor; and he should not be afraid of a possibility of error in 15 per cent. of the number of meters, because he took it that this was almost incidental to the initiation of the system. A very little time would doubtless put these meters right; and the experience that had been detailed in the paper read to them was in itself most encouraging in this respect.

Mr. D. Vass (Portobello) said he should like to relate one experiment he had made with a prepayment meter. That meter had been connected to a gas cooking stove; and it had been found to be very serviceable in this respect—that there was a servant in the house, and the mistress could control the quantity of gas used in cooking by the number of pennies that she gave to the servant. There was one point in Mr. Keillor's paper he was not very sure about—the amount he added on to cover meter rent. He thought they should keep this limit as low as possible: and his reckoning was—he had only gone into it on a small scale—that they should count upon 3,000 cubic feet per annum, and that their charge should be perhaps about 2s. for meter rent. That for a year, covering 3,000 cubic feet, would run to about 8d. per 1,000 feet beyond the price of gas. There was one point about these appliances—viz, that they had them always fitted on to dry meters; and if the consumption was anything like irregular—if it were stopped, for instance, for a few months in the year—he should fear that there would be a stiffening of the diaphragm of the meter. He had asked if he could not be supplied with wet meters; but there seemed to be a difficulty in fitting the prepayment appliance on to such meters. He thought, if they had it upon a wet meter, there would be more confidence among gas managers in recommending it. He had no hesitation in saying that it worked very well as it was, except for the drawback he had mentioned. Then, again, he thought that it should only be applied to new consumers. They had perhaps 1,000 consumers in a town; and if they were to be asked to put in prepayment meters to all these, what were they to do with the old meters, some of which might have been in use for only five or six years?

The President referred to the fact that there were one or two prepayment meters there for exhibition; and any gentleman who had not seen them at work, would have an opportunity of inspecting them in the interval.

Mr. D. Cheyne (Mountain Ash) stated that he had had a little experience with these meters, and he could indorse every word Mr. Keillor had said. He had had them in use for about three years, and he found that people, while they put in double the quantity of what their bill used to come to, never said a word about it. If they were to present a bill for (say) 5s., there would be grumbling; but consumers would put in 10s., and never make a single remark. So far as registering the quantity corresponding to the pennies put into the box was concerned, he had found no trouble at all with that. He once had a stop, but it was owing to a penny being bent; and after that he cautioned people always to put in perfect pennies. He might also say he found a 2 shilling piece in one of them, which, of course, he returned. The way they managed was this: They charged a penny for 20 cubic feet; and as their price 3s. 9d., this represented 5d. per 1,000 feet towards the expense of the meter. They had the money at the end of the year, and if there was anything over and above paying the meter rent, they returned it to the consumer. It ought to be done in that way, because there were no bad debts and no risks to be run; and he found that there were often a few pennies to be returned at the end of the year. In the case of cookers, he thought the prepayment system very suitable for persons who went away to the seaside for a time. They would sometimes have a great row with such people, who said they did not use the quantity of gas because they had been at the seaside most of the time. Well, he believed these meters were the right things, because, when the family went away, they had only to put so many pence into the box, and then, if the housekeeper were extravagant, she must find the money for the gas out of her own pocket.

Mr. A. MacPherson (Kirkcaldy) said he could not add anything to the discussion, having had no experience of prepayment meters; but he had no doubt that they would very soon take their place in gas works. It was quite evident that by that system they would be able to save a considerable amount of bad debts; and there was no doubt that there was a grievance against cookers on account of the waste that servants were guilty of, which could be obviated by the fixing of a prepayment meter. If they were able to say to a lady, when they gave her a cooker, that she could regulate her daily supply by this means, they would have more of them disposed of. He must say that he highly commended Mr. Cheyne's honesty in returning the few coppers that were over at the end of the year; and if all the consumers were treated in that way, they would very soon become friendly to prepayment meters. It certainly said a good deal for Mr. Keillor, that he had been almost the first in Scotland to introduce these meters.

Mr. R. Cowie (Tillicoultry) said he was very pleased to hear the paper read by Mr. Keillor, and was prepared to indorse everything he had heard regarding it. He had had some little experience with prepayment meters, having fixed about 11 of them for new consumers—that was, people who had never burned gas during his sojourn in the place where he was—and they had given the utmost satisfaction. With regard to the gas consumed and the money tallying with it, he had had no difficulty whatever. He might say that some parties applied to him for gas who were improvident in their habits, and he showed them what the cost would be with an automatic meter. They said they would be very pleased to have it, and he therefore had one fixed up. The first quarter he had 90d., and the second quarter—from November to February—13s. They were quite delighted with the meter, and stated that they would not part with it on any account. He had had some fixed in a house occupied by single women working in factories, who had had gas grills supplied to them. They never used a pennyworth of gas for lighting, as they burned paraffine; but they cooked with gas, and they said they would not do without it under any circumstances. He had been deluged with applications for automatic meters. He had over a hundred applications by people already burning gas, but he demurred to supplying them to present consumers.

Mr. W. Chalmers (Alva) remarked that he had had some experience with prepayment meters, and they had given satisfaction. The money and the registers tallied; and he never had had any trouble with the meters stopping.

Mr. J. M'Crae (Dundee) said there was one point which had not been brought out, although he had been waiting for it. It had always appeared to him to be a great hardship upon poor consumers of gas that they should have to lodge a deposit. In Dundee, people could not get a supply of gas unless they paid a deposit or had a guarantee. It was a most difficult matter to find in a strange town anybody who would be security for them; and it was also a great hardship to pay 5s. or 10s. down before they could obtain a supply of gas. But the "penny-in-the slot" would get them a supply; and they could pay as they went. These meters would be a great convenience to such people.

The President thought they had had a very happy discussion upon the paper. He had one or two prepayment meters in use; and there could be no doubt that these appliances were destined to supply a want in the business of selling gas. There was no doubt about it; and it would be a great boon to the honest poor. Some poor people, if they could get a meter, would burn away at the gas without caring whether or not they could pay for it; but they had honest poor, who were frightened to burn gas for (say) three months without paying for it. Gas was not like any other commodity. They consumed it, and they had the light; and it was then past and gone before they had to pay for it. Mr. West had just informed him that in London these meters had taken a tremendous hold, and that the London gas companies had given manufacturers orders to send in as many as they could possibly make. He did not believe there would be any difficulty about producing a reliable meter, either dry or wet; and he should think it ought to be very easy to adapt the stopping principle to the wet meter. They know that some wet meters were not very difficult to stop without automatic appliances; and, in his opinion, it was only a question for the manufacturers whether they would make these meters wet or dry. He fancied, however, that wet prepayment meters were made at present. He was very pleased that they had had such a good discussion, because he was himself responsible for the reading of the paper, and he could assure them that he had very great difficulty indeed in persuading the author to come forward with his few notes. It must, therefore, be very gratifying to Mr. Keillor that his communication had raised such an interesting discussion. Mr. Valon, he thought, was the one exception; he was the only gentleman who had given them his experience as to the questionable reliability of these meters. He (the President) did not see how they could fail, seeing that they had always the ordinary index of the meter to fall back upon. If the consumer were really honest, and they found that there was not enough pence in the box to recoup them for the quantity of gas indicated on the ordinary index, he thought they would not have much difficulty in persuading him to pay the difference.

Mr. Keillor, in replying, said that the only thing he had to refer to was that, so far as the merit of the meter was concerned, he would not like his price to be taken at all, because he lived pretty far north. He put on 1s. 8d. simply to keep himself right in an experiment; but he thought 8d. or 10d. per 1,000 cubic feet would be a sufficient charge for meter rent.

The Action of Ammonia Gas upon Molybdenyl Chloride.

[By Messrs. Edgar F. Smith and Victor Lehner, of the University of Pennsylvania.]

In 1857 Tuttle (*Annalen*, 101, 285) studied the action of ammonia upon molybdenum trioxide, and molbydenum chloride ($MoCl_4$). In the case of the trioxide the temperature at which the reaction was made approached a red heat. The resulting product was in part black in color and possessed metallic luster. Its analysis revealed the presence of nitrogen, oxygen, hydrogen and molybdenum. The quantity of the latter constituent equalled 92.9 per cent. Upon conductivity the reaction at more elevated temperatures, the product was found to contain 77.9 per cent. and 73 per cent. of molybdenum, while the hydrogen content did not exceed 0.18 per cent. The results consequently were not constant.

On exposing molybdenum chloride to the action of ammonia gas at a temperature just sufficient to volatilize the ammonium chloride which arose in the reaction, Tuttle obtained a black, metallic sintered mass. It was found to contain 82.83 per cent. of molybdenum, and was assumed to have the composition expressed by the formula $Mo_2N_3 + Mo(NH_2)_3$, analogous to a compound of tungsten obtained in a similar manner by Wohler (*Annalen*, 73, 190).

Several years after the publication of the preceding investigation, Uhrlaub presented an inaugural thesis, entitled "Die Verbindungen einiger Metalle mit Stickstoff" (Goettingen, 1859), from which we collate the following interesting facts: In the action of ammonia gas in the cold upon molybdenum chloride much heat was evolved, and a black colored product resulted; its analysis showed the presence of 76.457 per cent. of molybdenum, 23.134 per cent. of nitrogen, and 0.677 per cent. of hydrogen. In subsequent experiment Uhrlaub employed a more intense heat, thus hoping to eliminate the slightest hydrogen content; but this element continued to show itself in his various products until, on raising the tube in which the reaction took place to an intense red heat, he obtained a compound that careful analysis gave a composition that may be expressed by the formula Mo_2N_3. In other words, a molybdenum nitride had been formed by acting upon the chloride of the metal with ammonia gas at a high temperature.

When Uhrlaub tried the action of ammonia upon molybdic acid at a gentle heat, he obtained "pseudomorphuen," as he designated them, bluish-black in color. Several were prepared; they varied much in composition. Uhrlaub attributes this variation to the different degrees of heat employed, and to the length of time during which the heated molybdenum trioxide was exposed to the action of the gas.

The preceding facts indicate that the action of ammonia gas, either upon the trioxide or chloride, is not as simple as might be presumed. An amide that might well be expected in either case appears not to have been obtained by either Tuttle or Uhrlaub.*

We hope to reach this result by the action of ammonia gas upon molybdenyl chloride, in accordance with the equation

$$MoO_2Cl_2 + 4NH_3 = MoO_2(NH_2)_2 + 2NH_4Cl.$$

It will be noticed that we apply the term molybdenyl chloride to the compound generally called molybdenum dioxychloride. Our assumption of molydenyl is based upon the terms sulphuyl, chromyl, etc., applied to compounds possessing a constitution similar to that of the dioxychloride of molydenum, MoO_2Cl_2, SO_2Cl_2, CrO_2Cl_2.

Preparation of Molybdenum Chloride.—Of the various methods proposed for the formation of this derivative of molybdenum we discovered that the action of dry chlorine upon the dioxide of the metal yielded by far the most satisfactory product, both as to purity and quantity. At a very gentle heat the molybdenyl chloride forms rapidly and sublimes in feathery crystals. Schulze (*Jr. Prakt. Chemie*, 29 (N. F.) p. 440), in discussing the action of molybdic acid upon metallic chlorides, proposes this procedure for the object we had in view, but we failed to meet with success in our application of the method. The yield was not very abundant.

The crystalline molybdenyl chloride, prepared as described, was introduced into porcelain boats, and these placed in tubes of hard glass, through which we conducted a brisk current of well-dried ammonia gas. The molybdenyl chloride immediately assumed a deep black color, much heat was evolved, and copious fumes of ammonium chloride vapor were carried out of the tube. Considerable moisture also collected upon the anterior portion of the combustion tube. At last heat sufficient to expel any ammonium chloride retained by the compound was applied; but it was not for a longer period than half an hour. The boat and contents were cooled in ammonia gas. The product of the reaction was placed over sulphuric acid to absorb any retained gas; a portion of it was also washed with water, and the aqueous solution examined for chlorine, but this was not found present. In general appearance the product was metallic and black in color. Analyses were made of different preparations. The molybdenum content was determined by oxidizing weighed portions of material with dilute nitric acid, evaporating carefully to dryness, finally applying a gentle heat for a period of 15 minutes.

The hydrogen was estimated by burning the material in a current of oxygen, and collecting the water that was produced in a weighed calcium chloride tube.

The nitrogen estimations were three in number; one of them was carried out by the method of Dumas, while the other two were made by the soda-lime process.

The oxygen was obtained by difference.

Our analytical results may be tabulated as follows:

Molybdenum Determination.

	MoO_3 Found.	Mo, Per Cent.
(1) 0.1047 gram substance taken.....	0.1156 gr.	= 73.65
(2) 0.1006 " " "	0.1108 "	= 73.42
(3) 0.1004 " " "	0.1110 "	= 73.70
(4) 0.1028 " " "	0.1113 "	= 73.47
(5) 0.1017 " " "	0.1126 "	= 73.80

The mean molybdenum percentage of these five determinations is 73.61 per cent.

Hydrogen Determination.

	Water Found.	H, Per Cent.
0.2088 gram substance taken.....	.0082 gr.	= 0.43

Nitrogen Determination.

	Pt. Found.	N, Per Cent.
(1) 0.1510 gram substance taken.....	.0643 gr.	= 6.05
(2) 0.1529 " " "	.0642 gr.	= 5.96

The nitrogen found by the Dumas method equalled 6 per cent., and the mean of the three nitrogen estimations was also 6 per cent.

Two thirds of this nitrogen content were expelled when our compound was exposed to the action of hydrogen at the highest temperature attainable with a good combustion furnace.

Taking the mean of our analyses as a basis of calculation—

Mo.....	73.60 per cent.
N.....	6.00 "
H.....	0.43 "
O (by difference).....	19.96 "

we deduce $Mo_3O_8N_2H_2$ as the most probable empirical formula, which may be variously written to express the enigmatical constitution of this compound. Thus it might be $MoO(NH)_2$. $MoONH$. $3MoO_3$, or $4MoO(NH)_2$, which may be correctly termed tetramolybdenyl molybdenimide.

Our compound is stable in the air. Hydrochloric acid does not affect it. Nitric acid of sp. gr. 1.42 causes it to burn very energetically. Dilute alkalies attack it very sluggishly. It liberates ammonia when fused with caustic potash. When heated in a current of oxygen it is slowly oxidized. Heated in nitrogen gas the black compound loses water and assumes a reddish color. An analysis of this product indicates that it was probably molybdenum dioxide mixed with a very small amount of nitride; at least, traces of nitrogen were found upon examination. Another interesting observation was that when the black product was introduced into an aqueous solution of silver nitrate, crystals of metallic silver gradually appeared over the surface of the molybdenum compound.

We obtained our first product several times, but care must be exercised, and the same conditions noted by us stictly observed, if success in its formation is desired.

An examination of Uhrlaub's analytical results show that one of his products approaches very closely the compound we have just described. He speaks of it as a black "pseudomorph" with the composition—

Mo	73.55 per cent.
N.....	5.58 "
H.....	0.54 "
O.....	20.30 "

The formula deduced from these figures differs from that presented by us; and what is more, if we understand Uhrlaub correctly, his compounds, prepared from ammonia gas and molybdenum trioxide, were all "blau-schwarz" in color, and were not acted upon in the cold by nitric acid (see his dissertation, pp. 13, 14, 17).

However, it is evident that the product we obtained by the action of

* The primary object of these gentlemen seems to have been the preparation of molybdenum nitrides.

ammonia gas upon molybdenyl chloride is not the amide we had in view. Thinking that perhaps the heat we applied to drive out the final traces of occluded ammonium chloride may have been sufficient to alter the composition of the product formed at first, we allowed the ammonia to act upon the molybdenyl chloride at the ordinary temperature, and when there was no further evolution of ammonium chloride, and the boat had become perfectly cold,* we introduced carbon dioxide, applying a very gentle heat at the same time, but we failed to achieve our aim. Nitrogen when substituted for carbon dioxide gave us no better result. We next dissolved molybdenyl chloride in the purest ether we could get, and conducted ammonia gas into this solution. We obtained decomposition products. A closer examination of the behavior of the molybdenyl chloride toward ether revealed the fact that the moment the two came in contact a slight hissing sound was perceptible, and the ether at once imparted a strong acid reaction to blue litmus. The same was observed when pure chloroform was employed as a solvent.

If molybdenyl chloride be gradually heated in an ammonia atmosphere until the tube of hard glass becomes bright red in color, and the gas action be continued for the period of an hour, the resulting product will be an amorphous, metallic, black mass. Subjected to analysis it gave results as appended :

Molybdenum Determination.

	MoO_3. Found.	Mo. Per Cent.
(1) 0.1042 gram substance taken	0.1061 gr.	= 67.87

Nitrogen Determination.

0.1025 gram substance burned with soda lime gave 7 per ct. N.

Hydrogen Determination.

0.1012 substance ignited in a current of oxygen gave .0109 gram of water, equal to 1.19 per cent. H.

Mo	67.87 per cent.
N.....	7.00 "
H	1.19 "
O (by difference)	23.94 "

The empirical formula deduced from these figures is $Mo_7O_{14}N_5H_{10}$, which can also be written

$$4MoO_3.2MoO_3(NH_2)_2.MoO_2NH_2.$$

Dilute alkalies have no effect upon this compound ; but it liberates ammonia when fused with caustic potash. It is converted into molybdenum trioxide very energetically—with evolution of sparks—when brought in contact with cold nitric acid.

Other products were obtained by us ; their analyses lead us to the conclusion that with us as with Uhrlaub the composition of the derivative depended wholly upon the length of time during which the gas acted upon the molybdenyl chloride, and the degree of heat employed in the experiment. It seems highly improbable to us that the amide $MoO_3(NH_2)_2$—molybdenyl amide—can be prepared after the fashion pursued by us, for it is quite certain that the heat of the reaction evolved in the first contact of the ammonia with the molybdenyl chloride exercises a very potent influence upon the composition of the product.

When we recall the action of ammonia gas upon sulphur trioxide and sulphuryl hydroxy chloride resulting in the compounds with the following constitution :

$$H_2N.SO_2.OH$$
$$HN\begin{cases}SO_2.OH\\SO_2.OH\end{cases}$$
$$N-SO_2.OH$$

The question that obtrudes itself is : Are not these products and their methods of formation types of the processes and results that have occurred not only in our studies described in this paper, but also in the studies of Tuttle and Uhrlaub ?† Are not their products as well as our own only residues of amide, imido, and nitrito molybdic acids ?

Above we have written for our first product the constitutional formulæ $MoO(NH)_2$. MoONH. $3MoO_3$, and $4MoO_2$. $Mo(NH)_2$, but after considering the sulphur types we would express our empirical formula $Mo_5O_9N_3H_3$ differently, as follows :

$$\left.\begin{array}{l} MoO_2 \\ \diagup \\ H-N \\ \quad > MoO_2 \\ H-N \\ \quad > MoO_2 \\ H-N \\ \diagdown \\ MoO_2 \end{array}\right\} Mo.$$

* Portions of the product removed at this stage and shaken with cold water decomposed into a mixture of blue and brown colored masses. The possibility of removing the ammonium chloride was, therefore, excluded.

† At least in so far as the action of ammonia gas upon molybdenum trioxide was concerned.

We have here several broken-down molybdenyl amide nuclei in conjunction, not chemically combined, with metallic molybdenum. Reviewing the behavior of the product which we thus graphically represent, we may be allowed to emphasize the fact that when it was brought in contact with an aqueous argentic nitrate solution metallic silver was precipitated, and this we know from Smith's observation is a property of metallic molybdenum. Further, it will be recalled that when our product was heated in an atmosphere of nitrogen it left a reddish-colored compound, which upon analysis approximated the requirements of molybdenum dioxide, and that traces of nitrogen were also detected in it. All these experimental facts find expression in our graphic representation above.

The second product obtained by us was even more active when introduced into a silver nitrate solution, throwing out metal quite rapidly, proving in our opinion the presence in it of even a greater quantity of metallic molybdenum than is contained in the first body. Similar reduced molybdenyl amide nuclei mixed with metallic molybdenum, could also be constructed for our second compound, and be in harmony with the observed deportment of this body if it were necessary.

The Limitation of Engine Speed.

[A paper read by Mr. Charles T. Porter before the World's Engineering Congress.]

The practical limitation to high rotative speed in stationary reciprocating steam engines is not found in the danger of heating, or of excessive wear. The causes of both these, it is now well understood, are to be looked for in defects of design or construction, commonly both, as they generally go together, and where these do not exist to a degree which is of practical moment, a bar to the proper employment of higher rotative speed appears long before a tendency to heat or wear is to be observed. Correct designs are now generally followed in both the fixed and the moving parts of steam engines and a high degree of truth is readily attained in their construction, so that it has come to be a simple matter to make engines which can be run at very high speed, quite free from either of these difficulties.

Contrary to the general belief, no objection to very rapid rotation is afforded by the development of centrifugal force in the fly wheel or band wheel. This the following exposition will make clear.

The centrifugal force of 1 pound making one revolution per minute, in a circle of 1 foot radius, is 0.000341 pound. This force varies directly as the radius in feet, R, and as the square of the revolutions per minute, r. Hence the expression $Rr^2.000341$ gives the centrifugal force in terms of the weight, W. This is a simple and convenient formula.

A handy formula is desirable for the centrifugal force developed in each 1 square inch of section of the rim of a fly wheel. This is obtained as follows : In a cast iron wheel of 1 foot radius, measured to the center of gyration of the rim, the value of W for each 1 square inch of rim section is 19.6. This number, multiplied into 0.000341, gives 0.0066836 as the centrifugal force, in decimals of a pound, of this ring at 1 revolution per minute. As both the centrifugal force and the weight vary directly as the radius, we have the expression

$$(Rr)^2 \times 0.0066836$$

for the centrifugal force developed in each 1 square inch of cross section of the rim of any cast iron wheel. For example, this centrifugal force in a wheel 5 feet in diameter making 300 revolutions per minute is 3759.5 pounds.

$$(2.5 \times 300)^2 \times 0.0066836 = 3759.5.$$

This is the sum of the centrifugal stresses, exerted equally in all directions, in the plane of revolution. What is the measure of the tendency of these forces to burst the wheel ?

Answer.—One-fourth part of these forces, 940 pounds, is resisted by the tensile strength of two opposite sections of the rim. This strength, for good American iron, may be taken at 20,000 pounds per square inch, aggregating 40,000 pounds in the two sections, giving a factor of safety of 40.4. So this wheel may be run at double speed, 600 revolutions per minute, with a factor of safety of 10.

The wheels of high-speed engines have generally solid rims, and no case of their bursting has, I believe, ever been known. Disasters from this cause have been confined to engines not designed to be run at high speed, and have sometimes occurred when the speed was only slightly accelerated above the normal rate. In these cases the wheels have been built in segments, with surprising disregard of necessary strength in the flanges and bolts by which the segments were held together. The American Society of Mechanical Engineers will do a good thing if it shall adopt 10 as the factor of safety in tensile strength, to be recom-

mended by it for all mechanical work, and shall also recommend that in segmental wheels the joints be made, if anything, a little stronger than the section of rim. In applying the formula given above, it will be safe to take as the value of R one-half the outside diameter of the wheel. This being greater than the diameter measured on the center of gyration, the computed centrifugal force will be greater than that really exerted.

Again, an objection to very high speed is not found in a tendency to knock on the centers. In a properly designed and constructed engine, in which the valves are correctly set, and which is run by steam, high speed tends to silent running. Noise from bad design or bad work, from insufficent lead given to the valves and from water in the cylinder is excluded from consideration.

It is admitted with pride that the bad consequences of these defects are aggravated by high speed. This revelation of them has wrought an entire change in engine construction, not yet completed, and even makers of slower speed engines have largely profited by it. But it is obvious that there is now no excuse for their existence. The only legitimate cause of knock on the centers is loose boxes, and knock from this cause is softened as the speed is increased, and at extremely high speed will disappear entirely, owing to the force of the steam at these points being absorbed in overcoming the inertia of the reciprocating parts.

Again, vibration is not an objection to very high speed, because it is an easy matter so to design and construct an engine and balance the running parts that it shall be free from vibration at any speed whatever.

Again, very high speed is not objectionable, *per se*. If an engine runs in silence, completely free from vibration, without any tendency to warm, and without wear of any running part, its very speed renders it an object of especial admiration, even to those to whom such speed is new. Whenever extremely high speed in a steam engine has caused any other feeling in the beholder than that of admiration, it has always been the case that it has been attended with something annoying, a noise or a jar, or some uncomfortable action, which ought not to have existed.

All this being true, there still remain two considerations of a controlling nature which require that the rotative speed of the engines shall be kept within moderate limits.

The first of these is that engines ought not to be run as fast as they can be. It must on reflection be obvious to every one that an engine should be capable of running, and that too with entire satisfaction, so far as its motion is concerned, a great deal faster than it is run. This is the solid ground of security and confidence. It means peace and comfort, and helps to make men sleep well o' nights. It means long life to both engine and builder. I do not know anything to which the ancient maxim, *in medio tutissimus ibis*, is more directly applicable. Observe the force of the superlative, *tutissimus*, considered as a positive statement, "in the middle course you shall go most safely." That is just what we want in mechanics, in all our progress, to go most safely.

The second objection to the employment of extremely high speed is a very serious one indeed. It is the large amount of waste room in the port which is required for proper steam distribution. In the important respect of economy of steam the high-speed engine has thus far proved a failure. Large gain was looked for from high speed, because the loss by condensation on a given surface would be divided into a greater weight of steam, but this expectation has not been realized. Far from it. The performance of this class of engines shows, instead, a positive, and in some cases a large loss in economy. For this unsatisfactory result we have to lay the blame chiefly on the excessive amount of waste room. It has been already pointed out by Harris Tabor that the ordinary method of expressing the amount of waste room in the percentage added by it to the total piston displacement is a misleading one. It should be expressed as the percentage which it adds to the length of steam admission, and then every one would see what a serious thing it is. For example, if the steam is cut off at one-fifth of the stroke, 8 per cent. added by the waste room to the total displacement means 40 per cent. added to the volume of steam admitted. Under these circumstances, it is obviously the duty and for the interest of builders of high-speed engines to adopt every expedient for reducing the amount of waste room that can be done consistently with the proper admission and discharge of the steam. For this, the first requisites are moderate piston speed and longer stroke.

Engines of 4, 5 and 6 feet stroke may properly be run at from 700 to 800 feet of piston travel per minute, but for ordinary sizes I would recommend and urge that 600 feet per minute be taken as the limit of piston travel under all circumstances. This would give from 300 revolutions per minute with 12 inches stroke to 100 revolutions per minute with 36 inches stroke, with which purchasers ought to be satisfied. I would ask builders, in their own interest, to resist the temptation to get the utmost out of a given engine, and to set their faces like a flint against the demand for short-stroke engines, which shall occupy but little room and from which the required power can be got by speeding up beyond the limit here proposed. But I am met with the objection that in this class of engines large waste room is a necessity to prevent breakdown from water in the cylinder—that of the two alternatives of waste of steam in this way and broken cylinder heads and pistons, purchasers prefer the former. I confess that I am thoroughly disgusted at the engineering which puts purchasers of engines in such a dilemma as this. Getting rid of water in the cylinder seems to be the prerequisite to any attempt to reduce the amount of waste room. Then by all means let it be the first object of builders of high speed engines to get rid of all possibility of water in the cylinder in an amount capable of doing any harm.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, August 10, 1893.

Electrolysis of Gas and Water Pipes—Household Ammonia—The Coal Market.

In my last letter I referred to the fact that a committee appointed by Parliament was engaged in taking evidence on the subject of leakage of electricity and the effects thereby produced upon gas, water and other metallic pipes or conduits, telegraph wires, etc. This committee have issued a report setting forth their conclusions upon the whole matter. They have decided upon a clause which, subject to modifications according to particular circumstances, is recommended for insertion in all bills or orders authorizing the use of large electric currents for other than lighting purposes. It gives preference to the use of insulated return lines, in connection with electrical tramways, but recognizes that these cannot always be used. Uninsulated metallic returns, if adopted, are to be of low resistance, and all reasonable precautions are to be taken both in regard to the design and construction, and also in the actual working of all and every part of the plant, to avoid injury by fusion or electrolytic action to gas, water or other metallic pipes or structures. It is further advised that the Board of Trade retain power to enforce such regulations as may from time to time appear necessary, and to claim penalty in case of default. There is an express stipulation that the proposed clause shall in no way apply to plant for electric lighting. In addition to this suggestion, some further information as to the conclusions arrived at from the evidence placed before the committee, is given in the form of recommendations. In the present state of electrical science the committee think it is not advisable to insist on the use of an insulated return. The accidents that have already occurred are attributed not so much to the principle as to the faulty details of construction, and they believe it possible to reduce the risks of similar accidents to a negligible minimum, if care is taken that the insulated return shall possess sufficient section and resistance to avoid the degree of potential that is responsible for injurious leakage currents. And works or plant constructed according to present arrangements are not to be affected by future ones, unless such is rendered necessary by the demands of public safety or convenience. The committee view any large increase of the overhead wire system with apprehension, and, in considering the effects of induction, recommend that undertakers proposing to employ large currents should be required to give ample notice to all users of small currents in the district concerned, to enable them to secure protection by adopting proper means of insulation. For telephone or telegraph companies a two years' notice is suggested.

This report is referred to in this letter, in regard to its bearing upon the safety of the distributing systems belonging to gas and water companies. These concerns simply require their pipes to be left alone, and so far the clause appears to meet them to some extent. These public companies are so sharply watched, and when brought to book find themselves confronted with unsympathetic tribunals, so that in dealing with this matter they have to look further than the mere injury to their property, or loss of gas or water. By the way, it is amusing to notice the grandiloquent language adopted in all electrical matters. That expression "negligible mininum" appears on a par with the word "installation," and the numerous array of adjectives that have been brought into use for giving verbal expression to the glories of the electric light.

Having regard to the great depression that has lately been experienced in the market value of ammonia and its products, it is interesting to notice that some endeavors are being made in the way of securing for that substance the position in the ordinary household which it is so

well qualified to occupy on account of its alkaline and volatile properties, which are a unique and useful combination. In the laundry, the nursery and the kitchen there is room for a chemically active and non-corrosive alkali, offering all the advantages of soda or potash and at the same time free from their defects. For softening water, removing acid or greasy stains from clothing or furniture, the compounds of ammonia are superior to those of fixed alkalies, whilst for raising dough for bread, pastry or cakes they are simply perfection, since they disappear under the heat of the oven and leave not a wrack behind. One of the preparations advertised is "Household Ammonia," sold in bottles as a solution, and the other is a fine powder, readily soluble in water, known as "Brother's Solid Ammonia," and certified to consist of pure bicarbonate of ammonia.

Previous remarks on the unsettled nature of the coal market are justified by a strike on a large scale, embracing the greater part of the coal producing districts of the country, which commenced about a fortnight ago. As yet there is no sign of a settlement, though it is not expected to be of long duration. Fortunately at this time of the year it cannot do gas undertakings any great harm, as most of them carry substantial stocks. The worst that can happen is some little inconvenience and expense for trimming, caused by breaking into stacks that otherwise would remain in reserve for the winter. But the events connected with it make the regular user of coal, whether for gas making or for any other purpose, consider carefully how he is to stand in the future. Just as the disturbing elements amongst the laboring classes, a few years ago, gave a great impetus to the introduction of machinery for drawing and charging retorts, and for the loading, unloading and conveyance of coals and solid material of every kind, so the present circumstances in the coal trade will open our eyes to the necessity of being provided for contingencies that have not hitherto been contemplated. Gas companies must have a regular supply of suitable material, just as they must have force of some kind. And the question will be, how to supplement the home supply of gas coal by means of foreign coal and petroleum, just as they have provided mechanical as a reserve for muscular power.

The present struggle is really a determined effort in the way of bringing brute force to bear on a falling market. During the last few years a great rise has taken place in the price of coals. To some extent this has been secured and maintained by artificial means, and such methods are never permanent. The bubble is sure to burst sooner or later. The increased market price has been promptly followed up by demands for increased wages on the part of the miners, which have been granted to the extent of 40 per cent. on the original rates paid. So that, by working for three or four days a week, the miner now secures an income equal to that of an average shopkeeper, and passes the rest of his time in such amusements, intellectual or otherwise, with a large proportion of "otherwise," as are suited to his tastes. In the face of the recent collapse of prices, the owners have naturally reminded him that alterations cut two ways, and that as increased wages followed the rise, so a proportionate reduction should follow the fall. Their case is that it is impossible to make both ends meet, and so they have declared a reduction of a little over half the increase, which still leaves a clear rise of about 15 per cent. on the old rates of wages. So confident are they as to the justice of this proposal that they offer to accept arbitration.

A quarrelsome old Devonshire squire was once approached by a tenant, with a view of putting an end to an old-standing quarrel. So far from reciprocating the friendly spirit, the irate landlord soon came to blows with his neighbor, much to the scandal of the onlookers, for he was a magistrate, and the time was a Sunday morning. After a prolonged struggle he threw his adversary, and getting on top commenced pommelling. "Now, squire," said a bystander, "fight fair, and let the man get up." "What! what!" said the squire, "do you think I'm fool enough to let him get up again after all the trouble I've had to get him down?"

And the miners meet their employers in somewhat the same spirit as that which animated the old squire. They say that they had job enough to get their present high rates of wages, and that they mean to keep them now they have them. And it is the stubborness and rejection of independent arbitration that augurs ill for the supply of gas coal in future, and shows that we must expect high prices or else irregular supply. So the moral of the whole thing is, "Get another string to your bow," and increased attention will be devoted to the cupola process for producing gas from coke and petroleum, to the obtaining of increased yields from coal, the enrichment of the same by the use of liquid hydrocarbons, or anything else that offers a means of directly or indirectly reducing their consumption of coal. Possibly, as has been the case in other similar disputes, there are other issues in the struggle, besides the accredited cause. It is possible that they may be dropped out of sight when a return to work is advisable. But a truce to suit the convenience of both parties is not an end to a campaign. Frequently it merely means a renewal of the struggle with greater determination.

A noticeable feature is that workingmen's agitators are allowed a degree of freedom of speech and action that would not be tolerated in any other country. Possibly the government has faith that the commonsense of the hearers will secure a liberal allowance for exaggeration due to the excitement of the moment. It is to be hoped that, in the bitter feelings engendered by the present conflict, this faith will not prove misplaced. An excited wayfarer once rushed up to a policeman and said, "Come with me; there is a free fight in the next street." The officer rejoined, "That's why I'm here. Stop with me and you will be out of it, too." That is the position that our government takes up with regard to labor disputes. Meanwhile, gas companies find themselves sailing between the Scylla of "Coal at our price or none at all," and the Charybdis of "Give us cheap gas, or we will have oil or electricity." Coal miners say, "Gas companies must have coal, and must pay whatever you like to ask." And gas consumers say that the residuals pay for the coal, and that gas costs nothing. Both parties agree in exaggerating the actual profits earned on gas stock. Neither would be willing to admit that the actual profits received on the sums invested rarely go over 6 per cent., and that a large proportion does not exceed 4. So there is really no room for the substantial reduction in profits that is frequently demanded whenever it suits the purposes of an argument to do so.

The Development and Transmission of Power from Central Stations.*

In his sixth and last lecture before the Society of Arts on the above subject, Professor W. Cawthorne Unwin, F.R.S., said that he wished to correct an error he had fallen into with respect to the lowest scale of charges of the London Hydraulic Power Company. Their lowest charge, it appeared, was not 2s. per 1,000 gallons, but 1s. 6d., at which one effective horse power per annum would cost about £35, and he understood a good deal was supplied at this lower rate. Having made this correction, he would pass on to consider the question of distribution of energy by steam. Usually steam boilers were placed near the engines, but in special cases the steam had to be conveyed considerable distances, as in the case of underground pumps in mines, which were sometimes supplied with steam from boilers at bank. It would, perhaps, have hardly been thought very reasonable to use steam in this way for a general distribution in towns. It should, however, be remarked that steam could very conveniently be distributed for heating purposes, and its defects in other respects might be balanced by its advantages in this. Considerable success had attended the plan in America. Its introduction was due to Mr. Holley, who adopted it for warming large buildings from a central station. The steam before being finally discharged into the sewers was taken through a series of coils over which air entering the building for ventilation purposes was passed, and hence most of its heat was taken up before it escaped.

As regards the question of general distribution of steam for all purposes, Mr. Emery had carefully studied the subject, and concluded that it could be successfully done where the distance did not exceed half a mile. Stations had been built at New York to Mr. Emery's designs; the largest, which was the first put down, had boilers of 16,000 horse power capacity, and another station had since been built to accommodate boilers of 3,000 horse power, of which one-half was now at work. Some 5½ miles of main were supplied from the down town station, and about 2½ miles from the up-town one. The steam mains were 16 in., 15 in., 13 in., and 11 in. in diameter, and the return mains for the condensed water 8 in., 6 in., and 4 in. The steam was supplied for driving engines, working lifts, lighting plant and general manufacturing plant. About 500 engines in all were supplied. The charge was based on the number of "kals" supplied, each "kal" being about 1,110 thermal units, and about 30 kals going to the horse power hour. When used for heating, the charge was at first based on an estimate of the amount required to properly warm the building, a plan which had proved not very satisfactory or equitable. For power purposes the charge was similarly based on the nominal horse power of the engines, which was also unsatisfactory. It appeared, however, that the company had succeeded in finding a satisfactory steam meter, which worked on the Venturi principle, and gave a graphic record of the amount used. The charge at first was 50 cents per 1,000 kals, equivalent to about ¼d. per indicated horse power hour, but now a sliding scale had been adopted, and to large consumers the cost was 40 cents per 1,000 kals., whilst to small ones it was 70 cents. These rates correspond to from £12 10s. to

*Engineering.

£7 10s. per indicated horse power per annum. In the case of certain users who required power at night, the charges were still further reduced to about £5 12s. per indicated horse power per annum. The pipes were laid in brick trenches and were clothed with slag wool, and the top of the trench was covered with planking. Expansion joints were provided every 50 feet. These joints had been the principal difficulty in the working of the system. Mr. Holley used stuffing boxes, but these leaked and required too much attention. Ordinary flat diaphragms did not give expansion enough, and so Mr. Emery had designed a special joint in which a very thin corrugated diaphragm was used. This diaphragm was not strong enough to withstand the steam pressure unaided, and so it was supported by loose flat plates. There were other difficulties of a practical kind, but as for these, it appeared that the loss of pressure was not serious, whilst the loss from leakage and radiation could, it was believed, be reduced to a comparatively reasonable amount—viz., about 5 per cent. of the carrying capacity of the pipe. From the facts he had brought forward in previous lectures, it appeared that the cost of the distribution was the important point. With steam it appeared that a 6-in. main would convey 260 effective horse power if the pressure was 45 lb., and 400 horse power if it was 75 lb. per square inch. With an 18-in. main at 45 lb. pressure, 2,400 effective horse power could be conveyed, and at 75 lb. pressure per square inch, 3,500 effective horse power.

Another system of distribution of power from a central station was by means of gas. This was no new problem. In the United Kingdom alone £60,000,000 capital had been invested in gas works, and the coal used was about 11,000,000 tons per year, which furnished 98,000 millions of cubic feet of gas. At the ordinary price at which lighting gas was supplied—viz., from 2s. to 3s. per 1,000 cubic feet, it appeared that, taking a gas engine to use 26.5 cubic feet of gas per horse power hour in ordinary working conditions, the cost per effective horse power per year would be from £8 to £12. The price of gas as given above included a very large sum as the cost of mains, which were required to supply an enormous number of small consumers. This large number of consumers also involved a correspondingly large number of connections and joints, thus leading to increased loss by leakage. If the gas were supplied solely for manufacturing purposes, simpler means would be needed, and there would be less leakage. The cost would then be very much less, even if gas of the same quality as used for lighting purposes was supplied. The cost of actually producing the gas was about 10d. per 1,000 cubic feet, and if it was sold at 1s. 6d. per 1,000 cubic feet to cover interest, depreciation, etc., an effective horse power per year would cost about £6. At Dessau an electric lighting plant was worked in connection with the gas works, about 160 effective horse power being used to generate the current. The gas company by this plan kept their old customers, and gained in several other ways, and the plan had had very good success. At Pittsburgh natural gas had been distributed on a very large scale for heating and manufacturing purposes, and quite successfully, in spite of the cost of collecting and conveying it a distance of many miles. Good coal at Pittsburgh cost from 4s. to 5s. per ton, and slack coal 2s. to 2s. 6d. per ton. The gas was first supplied to Messrs. Carnegie's works, being conveyed a distance of nine miles from the wells. The agreement between the firm and the gas company was that the latter should be paid the same that Messrs. Carnegie paid for coal, to do the same work, until the cost of laying the mains, etc., had been recouped, after which the charge should be reduced one half. This was done in 18 months. Since then the gas had been conveyed 18 miles to Pittsburgh, and he believed that afterwards it had been taken as much as 100 miles. At the ordinary pressure at which lighting gas was supplied—viz., 2½ in. of water, a 6-in. main would convey 260 effective horse power, and a 36-in. main 22,000 effective horse power. If the pressure were raised to 2 ft. of water pressure, and the velocity of flow to 45 ft. a second, a 6-in. main would convey 1,200 horse power and a 36 in. main 143,000 horse power.

Finally, he came to systems of electrical distribution. The first suggestion of this was due to Dr. Siemens, who stated in a lecture in 1877 that a copper rod 3 in. in diameter would convey 1,000 horse power for a distance of 30 miles. Shortly after this Deprez had conveyed experimentally 3 horse power to a distance of 25 miles, using a continuous current at 2,000 volts pressure. The efficiency of the transmission was 32 per cent. Electricians claimed that they could do nearly everything in the way of running machinery by electricity, and it had even been suggested that one day the Atlantic "greyhounds" might thus be run. He was quite ready to admit that they could do all they claimed, with one proviso—viz., that they were allowed unrestricted expenditure. The world, however, was not managed on these lines. In a good deal of what electricians had said, they seemed to have forgotten two things—viz., that for many years past it had been quite possible to convey power very considerable distances by means of electricity, but it had not been done because it was too expensive; and, secondly, to be practically successful it was necessary that the power should be supplied finally at a cheaper rate than it could be generated on the spot.

In certain directions, however, a good deal had been done in the matter of electrical distribution. In electric lighting a great deal had been accomplished, and the system seemed to be succeeding financially, but in such cases as Geneva, where gas cost 7s. per 1,000 cubic feet, it must be admitted that the electric light had not to meet, even on the ground of expense, a very dangerous rival. In other places the beauty and convenience of the light had often compensated for its extra cost as compared with gas. In one other case the electrical system had been very successful. He referred to tramway traction. At the present time there were some 5,000 miles of tramways worked by electricity in the United States. As far as he could discover, however, it did not appear that the cost of traction was much less than with horses, but greater speeds could be obtained, which was important in the case of the widely scattered suburbs of American towns. Thus within half a mile of the city of Buffalo the tramcars were run at a speed of 15 miles an hour. With the exception of a few cases, amongst which Buda-Pesth was the most important, all of the electric tram lines, so far as he could discover, which had been financially successful, had been worked on the overhead system. For the working of underground and overhead lines, with a 3 or 4 minute train service, electricity had also advantages. The motors could be distributed over the axles of several carriages, and the working cost appeared to be less than with steam traction.

In other directions the progress of electrical distribution of energy had been much slower. Taking the price as 6d. per unit, 1 effective horse power would cost £60 per annum of 3,000 working hours, which was much too large, save for intermittent machinery. Even at 3d. per unit the cost would be £30 per annum, and above that at which the same amount of power could be obtained in other ways. When the Niagara Commission met two years ago, there was in Europe only one installation where power was developed for the purpose of distribution as motive power to many consumers. This was at Oyonaz in France, not far from Geneva. Turbines of 250 horse power at Charmines generated a continuous current of 1,800 volts, which was transmitted about 8 kilometers by overhead wires to Oyonaz, where the potential was reduced by motor transformers and distributed partly for lighting and partly for supplying a number of small workshops. Nothing could exceed the general look of prosperity of the village when he visited it 18 months ago, but at that time he understood only about 30 horse power were used for motor purposes, and about 40 horse power for lighting. Another installation of about the same date was that at Schaffhausen, where 18 months ago one 360 horse power and two 60 horse power motors were being worked by electricity at a cotton mill. Another installation was that of M. Hillairet at Domene, near Grenoble, where a turbine of 300-horse power placed in a gorge, inaccessible for three months in the year, supplied current for working a paper mill 5 kilometers away, the efficiency of the plant being 65 per cent. All these cases were working with continuous currents, the source of the energy was water power, and the current was conveyed by bare wires on telegraph poles. In the future the alternating current system might replace the continuous current one, but at present electricity was only economically used to transmit power where the current was generated by water, and bare overhead wires were used to convey it. The most important plant now at work was at Genoa. A water supply for the above town had been obtained by leading off water from the Gorzente rivulet, an affluent of the Po on the Piedmont-Liguria frontier. The head works were situated at a point 2,050 feet above the town, and to reduce the head three service reservoirs had been constructed. At the first of these 730 gross horse power were available, and a similar amount at the second, whilst at the third, with a fall of 500 feet, about 1,000-horse power could be obtained. Three power stations had been erected at these points, turbines of 140-horse power being, in the first instance, put down in 1889 at the reservoir first mentioned, and the scheme proving successful, a second station was erected, from which power was distributed electrically to 15 motors in the valley adjacent, and to a 60-horse power motor at the Genoa railway station, supplying power for driving dynamos, etc.; 600 horse power, at the same time, were taken off by a teledynamic transmission to drive factories in the neighborhood. From the third station power was distributed for driving dynamos, the machinery of the repairing shops of the railway, and to other factories.

The system was a constant current, series system, the voltage being varied with the demands for power. At the first station, where there was a turbine of 140-horse power connected to two dynamos by a Raf-

fard coupling, the voltage was varied by changing the speed of the driving turbines, the range of regulation being from 20 to 475 revolutions per minute. There were two 6-pole generators coupled in series, which supplied a current of 47 amperes. At the second power station the main dynamos were arranged to run at constant speed, but the magnetic field was varied, by regulating the exciting current, which was supplied by a separate dynamo. This dynamo and the 15-horse power turbine driving it were made with very light moving parts, so as to respond quickly to changes of speed. The exciting current of this machine was supplied by still another dynamo used for lighting the station, which ran at constant speed, so that the magnetic field was kept constant. The sluice of the 15 horse power exciting dynamo was controlled by a relay governor, worked by a solenoid and core. This solenoid was connected to the main circuit, and altered the sluice opening by means of the relay, in accordance with the demand for power. This plan had given good results, but in the new station a return was being made to the plan of varying the speed of the main turbines. The current was distributed by an overhead conductor, consisting of a bare copper wire $\frac{3}{8}$ in. in diameter. The total length of this conductor was 30 miles. The efficiency of the distribution was 72 per cent., which was good, but not better than could be obtained by some other means.

Power was transmitted by an alternating current on the three-phase system between Lauffen and Heilbron. At the former place a cement factory, finding they had more water power than they required, had erected the necessary plant to convey current for lighting and power purposes to Heilbron. The dynamos at Lauffen, in the first place, gave 4,000 amperes at 500 volts; for transmission this was transformed up to 5,000 volts, and in reaching the town the potential was again lowered to first 1,400 volts and finally to 100 volts on the lamp circuits. The charges were 9d. per unit for lighting and 4d. per unit for power purposes, the latter being equivalent to about £42 per year of 3,000 hours per effective horse power. In November last only 11 motors, aggregating 32 horse power, were connected to the mains. As regards the three phase system, Mr. Brown, the designer of the dynamos used at Lauffen, had never spoken strongly in its favor, holding that it required complications in generator, line and transformers.

Finally, it would appear that from a steam station electricity could not be supplied for power purposes under £30 to £40 per working year.

Its use at this price was necessarily limited. On the other hand, in every important case of distribution he had been able to discover, and there were, in addition to those described, some important mining installations in America, the power was initially obtained from water. He had stated that there was no immediate prospect of a reduction in the cost of electrical distribution. In one respect it would seem to a mechanical engineer that the cost ought to be increased. Wires on wood telegraph posts did not appear to an ordinary mechanical engineer to afford adequate security or permanence in a great power distribution, on which the whole industrial life of a community might depend.

To bring water to Dijon, D'Arcy had built a concrete conduit 13 kilometers long, of the minimum size which would be accessible throughout. It cost about £1 per meter run. It seemed to him that the works of a great system of power distribution should be carried out in at least as permanent a way, but if wires were placed in such a conduit something would have to be added to the cost of distribution.

The whole project at Niagara had been so recently described in that room that he would not take up time by going over the whole ground again. At Niagara there was an almost unlimited water power, which could be utilized at almost a minimum of cost. It was near great industries, and there were great facilities for transport either by water or rail. The task of utilizing this power had been undertaken with the greatest boldness and the greatest command of pecuniary resources. Lastly, the transmission for 18 or 20 miles to Buffalo had to be undertaken at the outset, and if an electrician had had choice of the conditions of the problem, he could not have chosen them better. The distance of transmission was just great enough to leave electricity with only a single possible rival, and the problem of electrical distribution would be worked out here under the most favorable conditions.

In 1886 the small-arms manufacturers of the small town of Herstall, Belgium, formed a syndicate to carry out a large order. The society decided to erect new workshops fitted up with the most modern tools. The operations to be carried on involved the construction of a number of different factories, more or less distant from each other, and so arranged as to be capable of future extension. In these factories it was found necessary to arrange for 13 lines of shafting, taking a total of 200 effective horse power, or, allowing for losses in transmission, etc., 300 gross horse power. Electric lighting was also decided on, and for this an additional 160 horse power was required. If all these lines of shafting had been driven from a single steam engine by ordinary mechanical transmission, the losses would have been large, particularly when all the machines were not running, and it would not, moreover, have been easy to provide for future extension. If shafting was used, it was found that 40 tons of it would be required, as well as 30 tons of pedestals. Hence it was finally decided to transmit power from the engine to the 13 lines of shafting by electricity, which had proved quite successful.

In conclusion, he would consider the bearing of the whole matter on the question of the general distribution of power in towns. He thought it had been shown by many instances that where power was easily and cheaply obtained a demand for it grew up, and the advantage to the community was very great. Power could be distributed in various ways, at a cost which varied partly with the original cost of the power and partly with the interest on the distributing arrangements. There was no hope that the cost of distribution could ever be made small, and the engineer was forced, therefore, to study the cheapening of the production of the power. Where water power was available it had enormous advantages, which in many cases would lead to the transfer of industries to new localities. As to steam engines, we had probably reached nearly the limit of improvement, and little was to be hoped from any direct modifications. With gas engines there was perhaps a somewhat larger, but still not very large, prospect of reducing the cost at which power was produced. He had endeavored to show that at present in central station working the conditions were very unfavorable to the cheap production of power, by any form of heat engine. The fundamental difficulty was the variation in the demand for power, and the expensiveness of any form of storage hitherto tried.

There was one method of proceeding which would ameliorate these prejudicial conditions of central station working, and that was the multiplication of the demands supplied from the station. The London gas companies were finding the advantage of combining, with their primary object of lighting, the supply of power and heat. In an address to the Institute of Gas Engineers, two years ago, Mr. Trewby stated that there were in London alone 2,500 gas engines and 60,000 heating stoves rented from the gas companies, besides probably 10,000 others privately purchased. Comparing two similar days in June, 1880 and 1890, the night consumption between 8 P.M. and 3 A.M., increased from 13½ to 16 million cubic feet, whilst the balance or day consumption increased from 9½ to 16 millions. The night consumption, therefore, increased in 10 years 20 per cent, but the day consumption 73 per cent. This meant not only an additional output, which in itself was a source of economy, but also a better distribution of the output. In the New York steam supply it was a very distinct advantage that the double requirements of heating and power could be met, and indirectly lighting also, where the steam was taken to drive an electric plant. At Zurich and Geneva the costly hydraulic works could hardly have been undertaken but for the fact that diverse wants could be met—viz., water supply, power distribution for industrial purposes, and power supply for electric lighting. In Paris the compressed air was used for power, for refrigeration, for driving an electric lighting sub-station, and for ventilation. At Cologne the water supply and electric lighting stations were combined, so that when power was not required for lighting it could be used for pumping. At Dessau the gas company erected an electric lighting station, directly on the principle that the use of the gas in driving the gas engines of the electric station would add to their profits as gas makers, as well by meeting the demand for electricity.

In proposing a vote of thanks to Professor Unwin for his lectures, Professor W. E. Ayrton, F.R.S., who has presided at all of them, said that such a course had long been wanted, and he thought no one was better fitted to deliver it than Professor Unwin. He thought the matter had been put before them with perfect justice, but with regard to electricity he thought it should be borne in mind that the question of electrical distribution of power was in its infancy, whilst the other systems had been worked for years. Hence greater improvements were to be expected in the former than in the latter. With the gas companies the price charged to consumers had steadily gone down since the works were inaugurated, and the same would be the case, he thought, with electricity. He had just learnt that the City of London Electricity Supply Company had reduced their charges to 4d. per unit, or only one-half of what was charged a short time ago.

THE National Heat and Power Company, of 138 South 6th street, Philadelphia, has just closed a contract with the Elkhart (Ind.) Gas Light Company for a plant equal to the production of 200,000 cubic feet per diem.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

VALPARAISO, IND., August 18, 1893.

Dear JOURNAL: The writer, in company with Mr. Frederick Waugh, of Chicago, recently made a very enjoyable visit to the new works of the Cicero Gas Light Company—Cicero is a suburb of Chicago, on the Northwestern Railroad. We were met at the Company's fine new office (which is most complete in every respect) by Mr. E. E. Morrell, the efficient engineer, who, after showing its advantages and conveniences, gave us a delightful drive through the paved avenues and past the elegant residences of Cicero, Oak Park and Austin, to the works, 1½ miles from the city office. The works were built under the direct supervision of Mr. Morrell and are certainly a model of convenience and utility. The purifying house is especially constructed for labor-saving. The four boxes are supported on I-beams, without columns or anything to obstruct the lower floor, which is of concrete, hard and smooth. Each box has an opening below for emptying the purifying material, which, after being worked over and revivified, is elevated, and, by means of a conveyer, running the entire length of the building, can be deposited in any box at the convenience of the operator. The generator house is large, and, like everything about the works, is equipped with all the modern improvements. There are two holders, oil tanks placed underground, a well-arranged settling tank, separate water works, a fine two-storied pressed brick office, finished in oak and containing the station meter, testing apparatus, reception rooms, etc. The Company has ample grounds, and buildings are erected with a view to future extension, provision for which is made in their location. The Engineer takes commendable pride in the plant which has been in operation 90 days. They have already about 27 miles of mains, and have put in some 450 gas ranges exclusive of hot plates and other cooking and heating appliances. With the immense territory contingent, rapid growth, admirable location and efficient management, the outlook is certainly flattering for the enterprise.—J. W. STRATTON.

ON the visit to Cicero, Mr. Stratton met George B. Burns, who is at present located at Austin—adjoining Cicero—where he is engaged in the gasfitting and gas fixture business. He looks well and is happy.

MR. A. E. LOESER, of Baltimore, Md., has gone over the plant of the Fredericksburg, Va., gas works, having been retained by the Gas Committee of the City Council (the plant is operated by the municipality) to report that which should be done to rehabilitate the works. It is possible that a water gas system will be introduced, and it is likely that a new holder will be arranged for. The last named vessel is sadly needed. Meanwhile, the attention of the advocates of the municipal operation of gas works is called to the Fredericksburg sample, although on the whole they had better look over it, for it will afford them only sorry comfort.

THE plant of the Wallingford (Conn.) Gas Company was slightly damaged by fire some days ago. It is supposed the flames were started by some tramps who had been ordered off the premises by the night watchman.

THE Allentown (Pa.) Gas Company has put down 10,000 feet of main pipe this season, and will add 4,000 feet more before the winter days are upon us.

THE report that the plant of the Woburn (Mass.) Electric Light Company would be offered for sale for the purpose of satisfying a $35,000 mortgage held by Dr. John M. Harlow of that city has occasioned much interest. Dr. Harlow states that the past year's interest has not been paid, and no heed was taken by the Company of his repeated demands for it, hence his action. It is also asserted that the Company is in debt to the Thomson-Houston Company to a considerable amount. On the other hand, an official prominent in the management of the concern says that the Company was never in better financial condition and was never better equipped than it is at present. He says, no matter what the outcome of the foreclosure sale is to be, the Company will continue to do business.

THE proprietors of the Cambridge (Mass.) Gas Light Company have ordered a reduction of 15 cents per 1,000 in the selling rate. This means $1.35 per 1,000 for the future. Good enough.

A CORRESPONDENT at Buffalo, N. Y., forwards the following: "On and after September 15th the Owego (N. Y.) Gas Company will be under different management. Supervisor A. P. Storrs, G. A. King, and a resident of Philadelphia, have, it is said, purchased a controlling interest in the Company, and will on that date take possession. They have already ordered a new gasholder, and the works will be equipped with new and improved machinery for making the best quality of coal gas. The Company will reduce the price of gas from $3 per 1,000 cubic feet to $2, and will equip residences and stores with gas fixtures of any and all kinds, furnish gas stoves of any desired make, or enter into contracts to light consumers' premises at so much per year. Several of the storekeepers of the town have agreed to discontinue the use of electric lights and oil, replacing the same with gas, when the improvements on the gas plant are completed."

"OBSERVER" writes: "The town of Wakefield (Mass.) and the Citizens Gas Light Company having failed to agree on the price and on what terms and conditions the Company shall sell its gas and electric plant to the town, and the Supreme Court having been petitioned by the Company to adjudicate between the parties, and said court having decreed that a Board of Commissioners be appointed by itself for the purpose of determining the aforesaid price, terms and conditions of sale, the counsel for the town and the counsel for the Company have (at the suggestion of the court) mutually agreed upon the following named gentlemen to act as such Board of Commissioners, providing they are approved and appointed by the court: Edwin B. Hale, of Cambridge; Ira T. Drew, of Boston; Samuel L. Powers, of Newton. If the decision of this Board of Commissioners does not prove satisfactory, either party (the town or the Company) may apply to the Supreme Court and have a hearing upon any question of law or fact passed upon by the Commissioners, and the final finding of the court will be conclusive on both parties. The town must buy and the Company must sell at the price and on the terms and conditions thus determined."

THE plants (both gas and electric) of the Nevada (Mo.) Light Company, which were badly run down, are being put in first-class shape, under the supervision of the Superintendent, Mr. O. H. S. Kennedy.

WE regret to record the death of Mr. Daniel Trowbridge, President of the New Haven (Conn.) Gas Light Company, which occurred on the afternoon of Friday, August 18th. Deceased was born in New Haven in 1820, and had been actively engaged in the shipping business of that port for over half a century.

THE Consolidated Gas Company of Baltimore has notified the County Commissioners that if an order is given for the erection of 12 street lamps on Ingleside and Beaumont avenues, in the Catonsville district, the Company will extend its mains to these avenues, provided certain conditions are complied with by certain parties who asked for the lamps. President Magruder said he wanted to know the cost of the lamps before passing the order, although the commissioners are willing that they should be put up, so the proposition went over for further consideration.

MR. J. WATTS MERCUR, of Wallingford, Pa., recently petitioned Judge Clayton to compel the Media Electric Light Company to turn on the current in his house. Mr. Mercur contracted with the company to furnish light for $52 for the first 18 lights, and $2 for each additional light. The house having been wired, and when everything was in readiness for the service, the company refused to turn on the current unless Mr. Mercur signed a contract to pay $3 for each light. The judge issued a mandamus ordering the company to turn on the light, the amount of compensation to be adjusted at a subsequent time by the court.

THE Derby Gas Company, of Birmingham, Conn., has given a trust deed to Messrs. David Torrance and Charles H. Pine for the purpose of securing an issue of $75,000 bonds recently disposed of by the Company.

FROM a local source we learn that the Hyde Park Mutual Gas Company, of Chicago, has voted to increase its capital stock to $1,100,000, and the stock has been offered to old stockholders at par, and the first assessment is payable Sept. 1. Last fall the shareholders authorized the Directors to increase the stock of the Company at such times as they saw fit up to $5,000,000. At the time the proprietors thought an ordinance would be obtained from the city allowing the Company to come north of its present limits, and it was the intention to issue stock for the purpose of paying for these extensions. Extensions within its territory were undertaken. The capacity of the works was enlarged from 1,500,000 to 2,500,000 feet, and the main system was largely extended. The capital was increased last spring to $1,000,000; and this last increase is to provide funds for completing the payments for these various improvements. Officers of the Company say that earnings are now equal to 8 per cent. on the stock, and they profess to be entirely satisfied with the situation. There has been a report that a move is in hand looking to the selling out of the Hyde Park Company to a new syndicate, which

would use it as a menace against the Chicago Gas Company. There have been rumors of a big scheme in that direction, and some work has been done in New York looking toward the raising of funds for carrying out such a plan. In regard to the likelihood of such a campaign being carried through, Mr. John J. Mitchell, of the Hyde Park Company, said: "There is absolutely no intention of selling this Hyde Park Company out, either to the Gas Trust or to competitors of that Company. I have myself heard rumors of that character, but they are absolutely unfounded. The controlling interest of the stock is in the hands of a Trustee, so as to prevent just such a thing as this occurring. We are perfectly satisfied to go along with the business, and that is what we shall do. The Company is not for sale, and it will not be sold."

THE proprietors of the Commercial Natural Gas Company, of Bradford, Pa., have issued notice to the effect that they are ready to make contracts for a supply of natural gas on the following basis:

	Yearly Rates.	Monthly Rates.
Cook stove.....	$12 00	$1 25
First heating stove	8 00	1 50
Second heating stove.....	6 00	1 10
Third heating stove	4 00	75
Each additional heating stove..	4 00	75
Common lights, 1 to 5, each ...	1 08	10
Common lights, 5 to 15, each ..	81	07½
Each additional light.....	54	05

MR. C. CHAMBERLAIN has been appointed Superintendent of the Hackensack (N. J.) Gas Light Company, vice Mr. E. U. Slade, deceased.

THE capitalists interested in the reorganized Sunbury (Pa.) Gas Company are the Brothers Rockefellar (C. G., W. M. and D. P.), S. P. Wolverton, H. Long, H. Lyon, and George B. M. Hile. Mr. T. H. Purdy, who formerly controlled the Company, has parted from all interest therein.

IT is reported that the Common Council of Auburn, N. Y., has decided to light the public streets exclusively with arc lamps.

MR. F. LINDBLOOM, City Clerk of Manistee, Mich., gives notice that the Common Council of that city will receive sealed proposals for lighting the city by electric arc lights of full 2,000 candle power for the period of one, two, or three, years from and after September 17, 1893. Bids will be received until 5 o'clock P.M., Sept. 1.

THE oil storage plant of the Waterville (N. Y.) Company's works was slightly damaged by fire a few days ago.

AT a meeting of the Light Committee of the Montreal, Canada, City Council, held about a fortnight ago to consider the matter of a contract for public lighting in that city, a proposition was submitted by Messrs. Coates & Co., the proprietors of an opposition Gas Company, under which they agreed to supply gas of 21 candle power at $1 per 1,000 cubic feet, with 5 cents per 1,000 off for prompt payment, provided the city granted the Company a 10 year contract. In the discussion of the proposal an opinion was read from the City Attorney to the effect that the Coates concern could not take "forcible possession" of the streets; for it was not chartered. Mr. Badger then submitted the report which he had prepared from the books of the Montreal Gas Company, showing relatively the proportion of gas used for heating, cooking and lighting in the following streets:

Street.	Light Per Cent.	Heat, Per Cent.
St. Hubert.....	59	41
St. Denis.....	63	37
Sherbrooke	67	33
St. Andre.....	54	46
Cherrier.....	59	41
St. Lawrence.....	79	21
St. Antoine.....	55	45
Dorchester.....	67	33
Notre Dame.....	87	13
Mountain.....	76	24
Crescent.....	55	45
Bleury.....	81	19
St. Alexander.....	75	25
Approximate average.....	67	33

The object of this presentation was to show that the average price received for gas by the old Montreal Company was not so greatly in excess (the Company charges $1.25 for lighting and $1 for cooking and heating purposes) of that proposed by the Coates concern. Ald. Prefontaine claimed that this was not a fair average of the city's use of gas, and asserted that the quarterly sendout for which $1 per 1,000 was paid would not really average 8 per cent. of the total sendout. Others of the Committee having participated in the discussion, Ald. Prefontaine moved the following: "That after having duly examined and considered the different tenders received for the lighting of the city and the supplying of gas to the citizens for lighting, cooking, heating and manufacturing purposes, your Committee come to the conclusion to recommend the acceptance of the offer of Messrs. John Coates & Co. as being the lowest tender and the most advantageous to both the city and citizens of Montreal, and that permission be given to them to construct at once their works and lay their pipes in the streets, lanes and public places in the city of Montreal, the whole nevertheless subject to the following conditions, besides those mentioned in the specifications adopted by the Council: *First*—The price of said gas, which shall be of not less than 21 candle power for all purposes, shall be $1 per 1,000 cubic feet, one meter only being used, and a reduction of 5 per cent. shall be granted for prompt payment. *Second*—Said privilege of supplying gas as aforesaid shall be for 10 years, to be reckoned from the 1st of May, 1895, and shall be only subject to the rights of the Montreal Gas Company as to competition. *Third*—The city at the expiration of the said 10 years shall have the right to buy the gas works, pipes, and all the plant of said John Coates & Co., or their substitutes, on the same conditions as mentioned in the by-law concerning the Montreal Street Railway, and if at the expiration of the said 10 years the said city has not availed itself of said right, the said John Coates & Co., or their substitutes, shall be bound to continue to supply gas on the same conditions for another 10 years." This proposition was vigorously debated, and was finally adopted on division, the vote being three in favor to two against.

THE Common Council of Pawtucket, R. I., has voted to "indefinitely postpone" the consideration of the favorable report from its special committee appointed to investigate the feasibility and desirability of engaging the city in the operation of an electric lighting plant.

MR. JOHN ALDRIDGE, well known as a constructor of benchwork and general masonry about gas works, died at his home in Greenpoint (Brooklyn, E. D.) on the evening of Saturday, August 19. Deceased was in his 81st year. On the completion of the new works of the New York Gas Light Company (21st street and avenue A), now a station of the Consolidated Company's system, Mr. Aldridge was engaged to overlook the benchwork and keep the same in repair. We believe that station was completed in 1848.

IN times like these, when almost every manufacturing concern is complaining of hard times and lack of orders, it does one good to find occasionally a Company which is running full time and has plenty of work ahead. The Berlin Iron Bridge Company, of East Berlin, Conn., is full of orders and is running its entire plant full time, and portions of the shop are at work overtime. It has contracts for a large amount of work, including a new electric light and power station at Lynn, Mass.; a drawbridge at Salem, Mass.; a new foundry building for the New Home Sewing Machine Company, at Orange, Mass.; an iron building to go to Tampa, Fla.; a large bridge for Chester county, Pa.; a new iron storehouse for the New York Knife Company, at Walden, N. Y.; a large power plant for the Philadelphia Traction Company, Philadelphia, Pa.; a large cotton shed for the Southern Pacific Railroad Company, at New Orleans, La.; a new roof for the purifier house of the Northern Liberties Gas Company, at Philadelphia, Pa.; a new power house for the Reading Traction Company, of Reading, Pa.; a new power house for the State Street Horse Railway Company, New Haven, Conn.; a car barn for the Easton (Pa.) Transit Company; a large smelter building for the Anaconda Smelting Company, Anaconda, Mont. Besides these contracts, the Company has numerous small jobs scattered throughout the country, which will employ its entire plant until after January 1st. The Company seems to be particularly fortunate in securing work like this at the present time.

THE gas works at Huntington, L. I., have at last been completed, and the residents are not slow in ordering services for their dwellings.

THE Indiana Gas Generating Machine Company, of Chicago, has been incorporated by Messrs. John A. Enos, Galesworthy G. Beresford and J. P. W. Brown. It is capitalized in $125,000, and proposes to "manufacture gas generating machines."

THE Peoples Electric Light Company, which has the contract for the public arc lighting of York, Pa., and the Edison Electric Light Company, which supplies current to incandescent electric lamps in the same city, have about agreed to combine their interests. The shareholders' meeting to ratify the deal is called for October 12th.

The Market for Gas Securities.

The general market remains practically unchanged, although since the time of last writing there was some genuine inquiry for Consolidated and Mutual, strictly on investment account. Consolidated opened to-day (Friday) at 117 bid, but holders refused to accept less than 119. During the week on the Exchange a total of 400 shares changed hands, the range being 122 to 117. Mutual was bid for at 130, but we have no idea that any stock could be secured at less than 135. Equitable nominally was weak and lower, and Standard, both as to the common and preferred, was neglected, although there is no change in the reported value of either. All the city Companies are in good shape, and the coming winter will find them fully up to the tasks that will be imposed upon them.

In Brooklyn gas shares no change of moment is reported; prices are nominal, however, and are decidedly not to be accepted as indicative of the actual values of the properties. We understand that the negotiations for consolidation are about to be actively renewed. There was some inquiry for Equity bonds at rising figures. The antics of the owners (?) of this property are positively painful to witness; in fact their attitudes are decidedly Fullerish. Some day they will, it is hoped, be satisfied to stand on a safe, financial basis. Chicago gas was strong and weak by turns. The sales on the Exchange for the week footed up 44,500 shares, and the range was 53 to 48⅛. The uncertainty as to the dividend is marked. The opening price to-day was 50⅜ to 50¾. Laclede common is offered at at 10½, and Baltimore Consolidated is strong, at 51⅜ to 52.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

August 28.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share. ☜

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	117	119
Central	500,000	50	90	95
" Scrip	220,000	—	—	100
Equitable	4,000,000	100	145	155
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	130	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	30	40
Preferred	5,000,000	100	75	80
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	—	110
Citizens	1,200,000	20	—	105
" S. F. Bonds	320,000	1000	—	103
Equity Gas Light Co	2,000,000	100	—	—
Bonds	1,000,000	—	—	60
Fulton Municipal	3,000,000	100	—	120
" Bonds	300,000		102	—
Peoples	1,000,000	10	—	90
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	—	120
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	—	150
" Ctfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	130	—
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	—	60
2d " " "	3,000,000	1000	40	—
Bay State Gas Co.—				
Stock	5,000,000	50	11	—
Income Bonds	2,000,000	1000	40	—
Buffalo Mutual, N. Y.	750,000	100	110	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
Chicago Gas Company.	25,000,000	100	50⅜	50¾
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	85	90½
Equitable Gas & Fuel Co, Chicago, Bonds	2,000,000	1000	—	101
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Consumers Gas Light Co., Jersey City	2,000,000	100	—	25
Bonds	600,000	1000	—	85
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	190	191
Central, S. F., Cal			—	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt.	11,000,000	100	51⅜	52
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
1st Mortgage			85	87

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Gas Posts and Street Lamps,

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Ironwork for Two Benches of 3's and One Bench of 5's, Complete.

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At Little Falls, Minn.

NOTICE is hereby given that the GAS FACTORY at Little Falls, Minn., with brick building 40 ft. long by 24 ft. wide by 14 ft. high, and Steam Engine, Retorts, Purifiers, Air and Water and Oil Pumps, together with all other apparatus for the manufacture of the Universal Gas, together with Boiler Iron Holder, with capacity of 12,000 cu. ft., and 1,900 ft. of 6-inch, 1,400 ft. of 4-inch, and 70 ft. of 2-inch mains all laid, with Connections and Service Pipes, 300 No. 19 Welsbach Lamps, 30 barrels Gas Naphtha Oil, 20 Gas Meters, with Repairs, Tools, etc., etc.; together with GAS AND ELECTRIC FRANCHISE for the city of Little Falls, also PATENT RIGHT for the manufacture of the UNIVERSAL PATENT GAS, together with the GOOD WILL of the Company, will be sold on

Sept. 5th, 1893, at 2 o'clock P.M.,

by the undersigned, at the said factory in Little Falls, Minn., to the highest bidder therefor for cash.

Each person or party desiring to bid shall, at or before the time of offering his said bid, deposit with the undersigned $500 in cash, or his bid cannot be considered; said $500 so deposited to constitute forfeit money for the faithful performance of the terms of the said bid. Any person desiring an inventory of the property constituting said gas factory and plant may secure the same by application to the undersigned.

Dated Aug. 7, 1893.

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Assg. of Peoples Gas and Electric Co.,
949-3 Little Falls, Minn.

FOR SALE,

Two Ten-Inch Dry Center Seals,

in good condition, and one

Small Multitubular Condenser,

4 ft. diameter and 14 ft. high.

For particulars inquire of FRED. BREDEL, C.E.,
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A GAS AND ELECTRIC LIGHT PLANT,

in a thriving village of about 10,000 inhabitants, centrally located. In first-class order and prosperous condition, with fine opportunity for extension. Address "GAS WORKS,"
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MANUFACTURERS OF

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Double and Single Gate, ½ in. to 72 in., outside and inside Screws. Indicator, etc., for Gas, Water, Steam, Oil and Ammonia.

SEND FOR CIRCULAR.

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ALSO,

Hydraulic Main Dip Regulators, Check Valves, Foot Valves, Yard Wash and Fire Hydrants.

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Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator.

Not Expensive. Write to
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MOSES G. WILDER,

Mechanical Engineer,

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Gas Governors,

Governor Gas Burners,

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In addition to a full assortment of Volumetric Governors, etc., I am now making **MERCURY PRESSURE GOVERNORS** of all the usual sizes, adapted to use upon *Gas Stoves, Furnaces, and Meters.* The same careful attention to details of design and workmanship which has established the reputation of **WILDER'S VOLUMETRIC GOVERNORS** will be given to the new line. They have been thoroughly tested in many places during the past year, and have given entire satisfaction. The price is very low, and but for a complete system of machinery adapted to this work, it would be impossible to sell them at the price. I hope for large orders, as they become known, in consequence of the low price and good quality.

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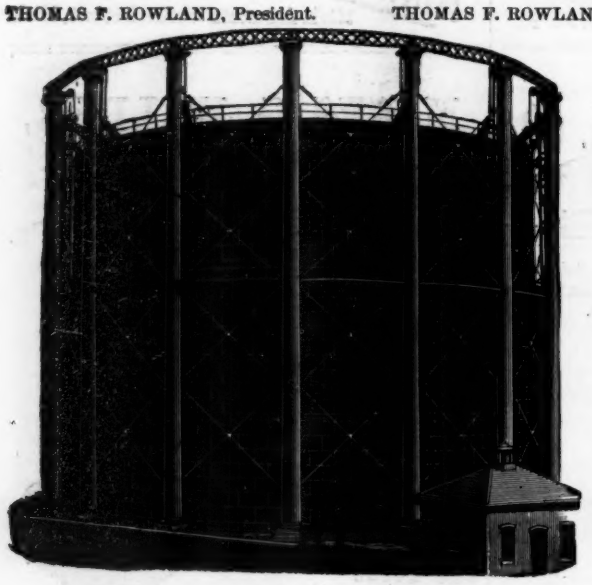

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Single and Multiple Section Gas Holders a Specialty.
Wrought Iron Gas Holder Tanks.
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Eleven Entirely New Ranges.

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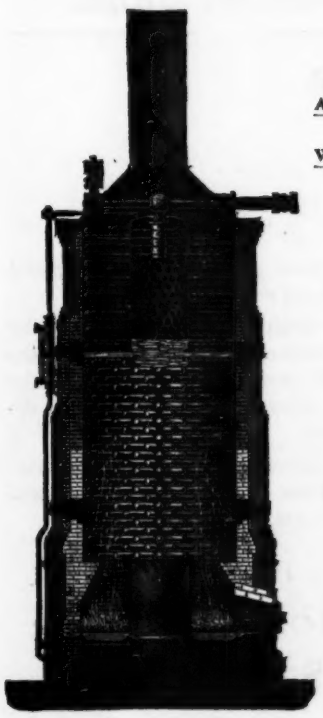
Patented in America and Abroad.



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An Unparalelled Record, of Over Twelve Years, for Economy, Durability, Safety, and Efficiency.
A Common-Sense High-Pressure Boiler made in a Superior Manner.
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THE HIGHEST STANDARD OF EXCELLENCE.

Standard Sizes, 50 H.P. to 500 H.P.

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Special Sectional Boilers For Export.

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This Company is prepared to Manufacture and Furnish Plants of Boilers of any desired capacity, and will forward proposals and other information on application. All imitations of the substantial features of this Boiler are infringements, and will be prosecuted to the full extent of the law.

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Cable Address, "PAILA," NEW YORK.
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Long Distance Telephone, 1229-18th St., New York.

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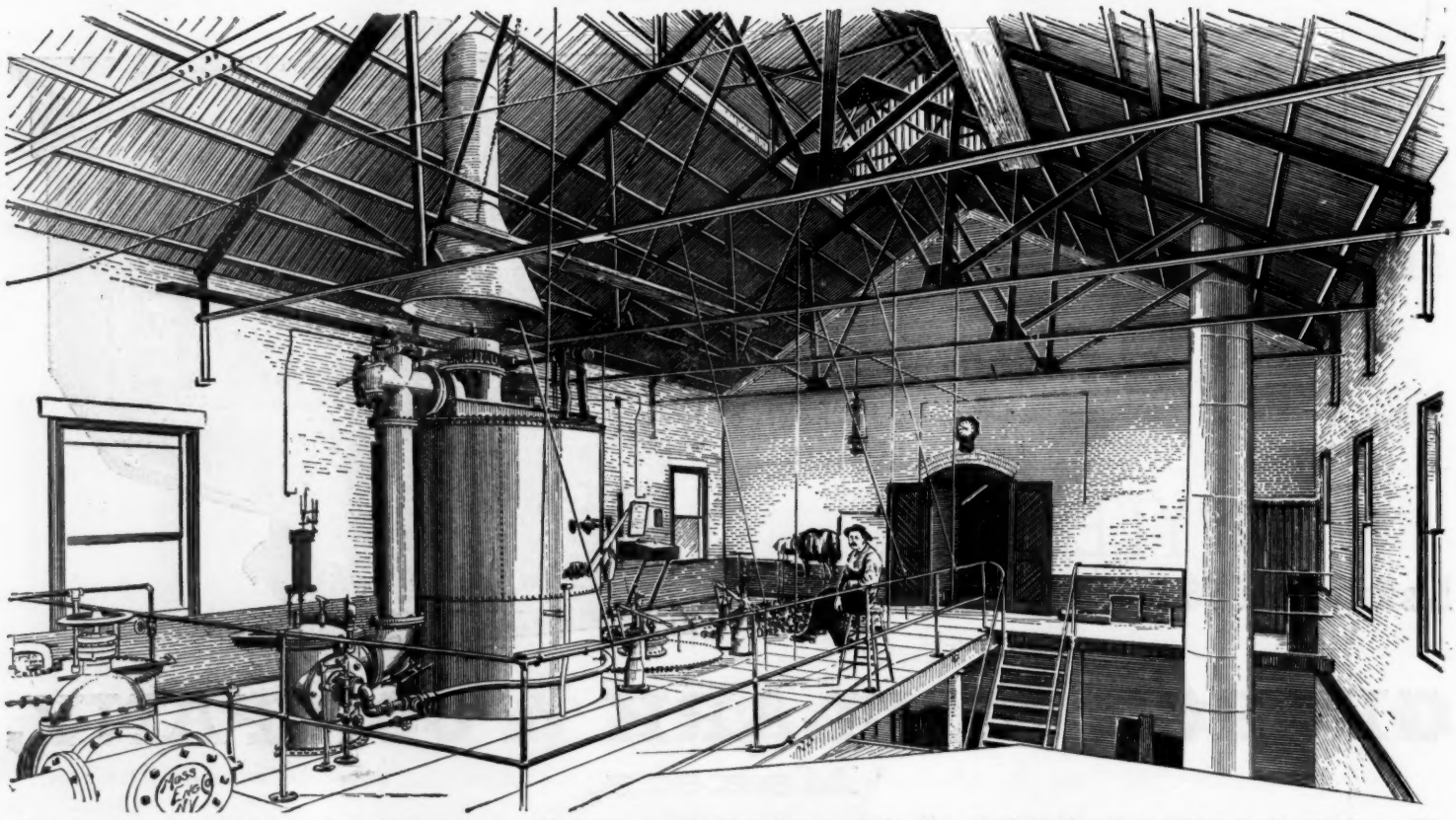

The above illustration is taken from a photograph, and shows the Machine Room of the New Bedford Gas Co., at New Bedford, Mass. The Roof on this building was furnished by us. The building is 32 feet in width by 50 feet in length, the Roof being made entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The room is ventilated by a wrought iron ventilator extending the full length of the building, with corrugated shutters on each side opening and closing by cords from the floor.

Write for Illustrated Catalogue.

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HIGH CANDLE POWER
FROM
GAS.

MR. WALTON CLARK, Assistant General Superintendent, United Gas Improvement Co.:

Dear Sir—In accordance with your request, I have made several ests of the new Welsbach mantel (called No. 169) for candle power and efficiency, and I herewith submit the following results:

	Candle Power.	Pressure.	Gas Consumed.	C.P. per Cu. Ft.
Average of Test No. 1,	67.05	.95 in.	2.6	25.70
" " No. 2,	63.86	1.00 in.	2.86	22.30
" " No. 3,	72.50	2.1 in.	2.87	25.26

The above averages are the results of trials on three different occasions, and in each case the mantles tested were made from a different lot of fluid.

The mantles used in the above tests were selected at random, and all had been dipped in kristaline and dried ready for shipment.

It is quite possible that better results could have been obtained by manipulating and readjusting the position of the mantles on the galleries, and also by waiting a longer period after burning off the kristaline; but I considered such fine adjustment undesirable in determining the commercial candle power.

These tests were made on a bar photometer against a regular Edgerton standard slit. The candle power of the slit was 6.18, and the gas used was Gloucester City water gas, 26 candle power.

Very truly yours,
(Signed) C. H. PAGE, JR., M.E.

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HIGH CANDLE POWER WELSBACH LIGHTS.

Gloucester, N. J. WELSBACH LIGHT CO.

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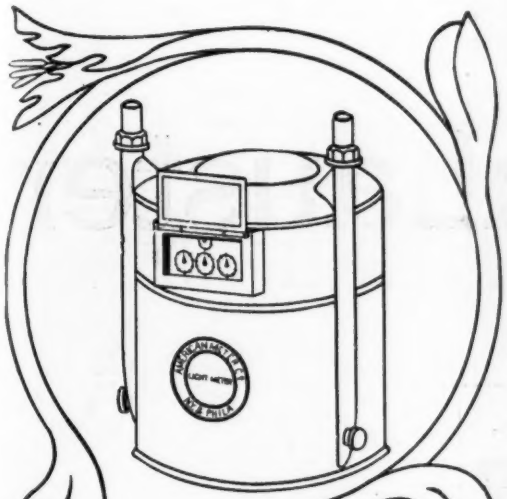

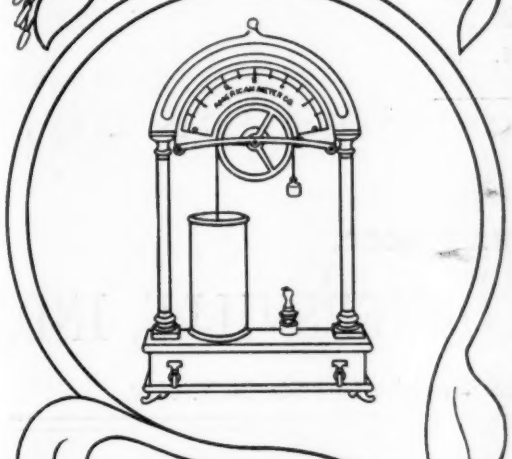

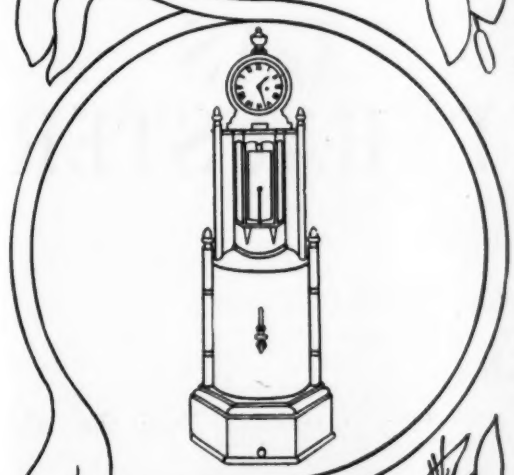

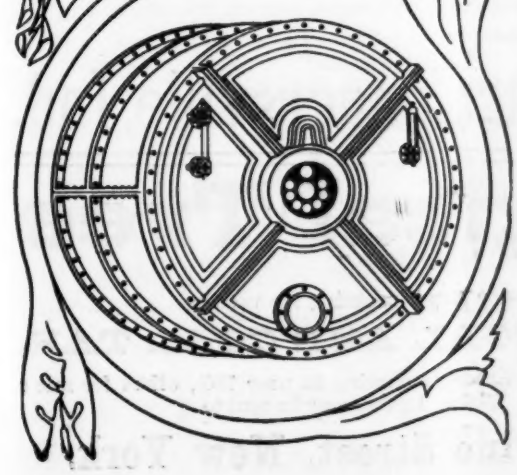

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ST. LOUIS. SAN FRANCISCO.

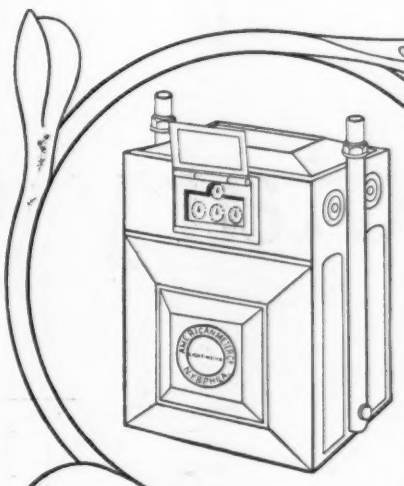
PUBLIC LIGHTING TABLE.

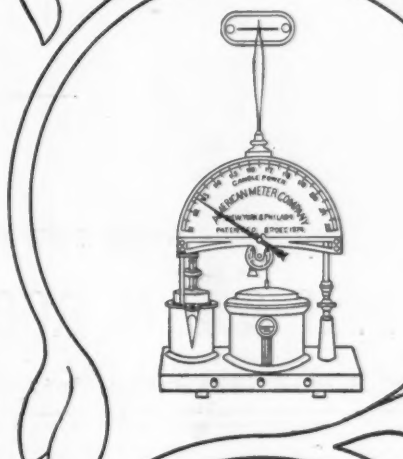
SEPTEMBER, 1893.

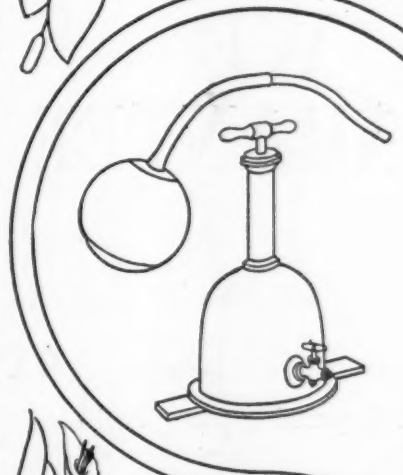
Day of Week.	Table No. 1. Following the Moon. Date.	Light.		Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
					P.M.	A.M.
Fri.	1	7.00	PM	10.10 PM	6.30	4.20
Sat.	2	7.00		11.00	6.30	4.20
Sun.	3	7.00	LQ	11.40	6.15	4.30
Mon.	4	7.00		12.40 AM	6.15	4.30
Tue.	5	7.00		1.50	6.15	4.30
Wed.	6	6.50		3.10	6.15	4.30
Thu.	7	6.50		4.30	6.15	4.30
Fri.	8	6.50		4.30	6.15	4.30
Sat.	9	6.50		4.40	6.15	4.30
Sun.	10	6.50	NM	4.40	6.05	4.40
Mon.	11	6.50		4.40	6.05	4.40
Tue.	12	6.40		4.40	6.05	4.40
Wed.	13	6.40		4.40	6.05	4.40
Thu.	14	6.40		4.40	6.05	4.40
Fri.	15	7.40		4.40	6.05	4.40
Sat.	16	8.20		4.40	6.05	4.40
Sun.	17	9.00	FQ	4.40	5.55	4.50
Mon.	18	9.50		4.40	5.55	4.50
Tue.	19	10.50		4.50	5.55	4.50
Wed.	20	11.50		4.50	5.55	4.50
Thu.	21	1.00	AM	4.50	5.55	4.50
Fri.	22	2.10		4.50	5.55	4.50
Sat.	23	3.10		4.50	5.55	4.50
Sun.	24	No L		No L.	5.40	5.00
Mon.	25	No L	FM	No L.	5.40	5.00
Tue.	26	No L		No L.	5.40	5.00
Wed.	27	6.20	PM	7.50 PM	5.40	5.00
Thu.	28	6.20		8.20	5.40	5.00
Fri.	29	6.20		8.50	5.40	5.00
Sat.	30	6.20		9.40	5.40	5.00

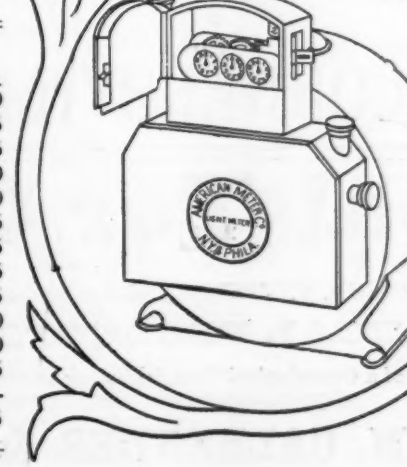
TOTAL HOURS LIGHTING DURING 1893.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January...	217.30	January...	423.20
February..	200.30	February..	355.25
March	177.50	March	355.35
April.....	160.30	April.....	298.50
May.....	149.00	May.....	264.50
June.....	140.30	June.....	234.25
July	143.40	July.....	243.45
August....	154.50	August....	280.25
September.	171.50	September.	321.15
October....	202.20	October....	374.30
November.	221.30	November.	401.40
December.	248.50	December.	433.45
Total..	2188.50	Total..	3987.45









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CYCLOIDAL EXHAUSTER,

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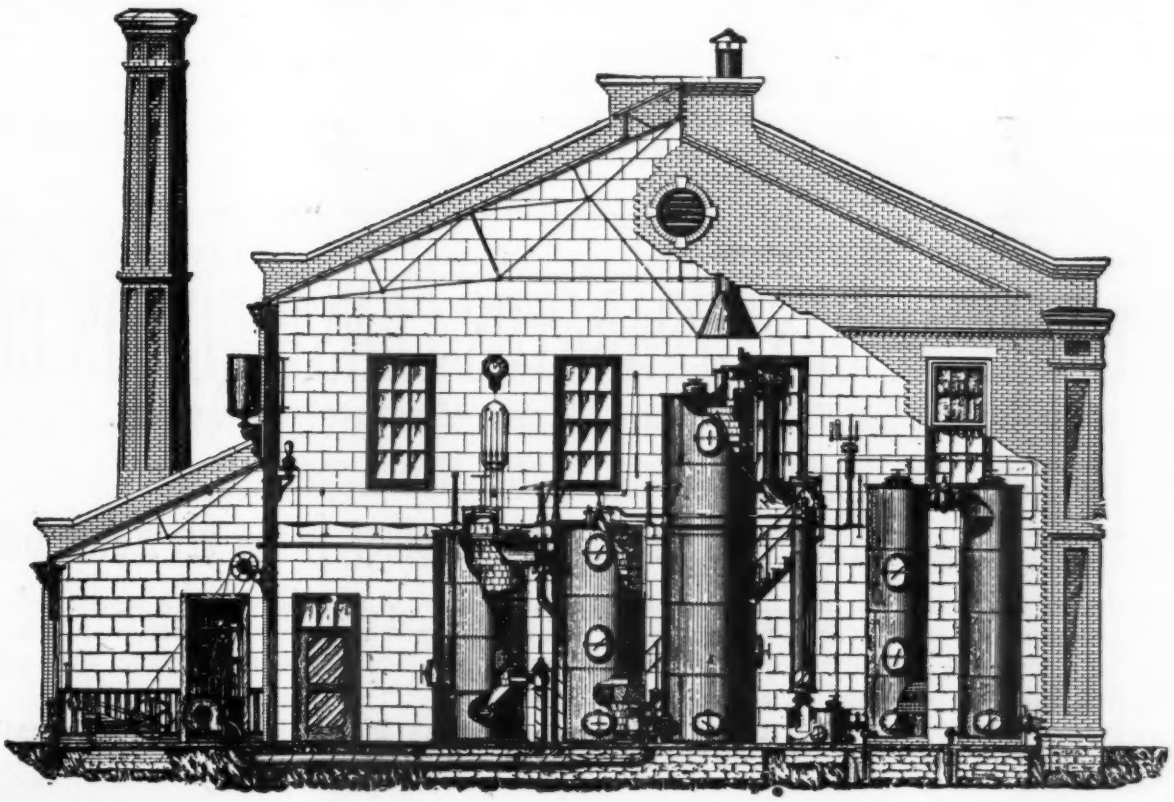

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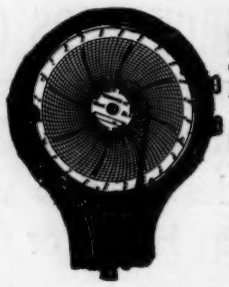

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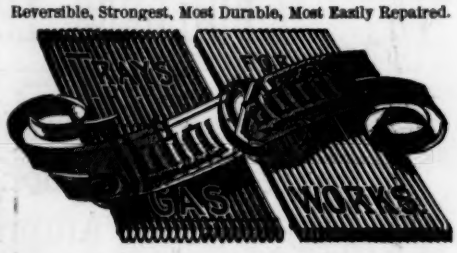

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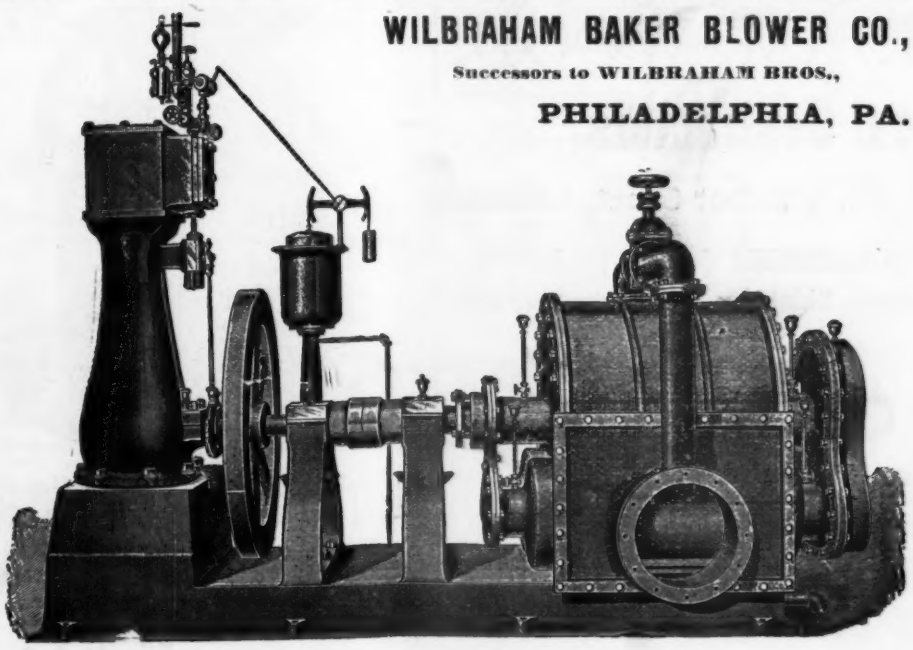

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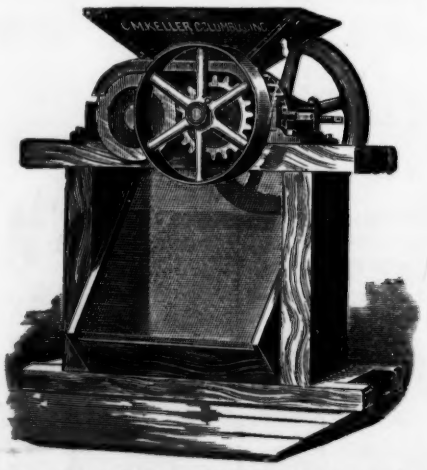

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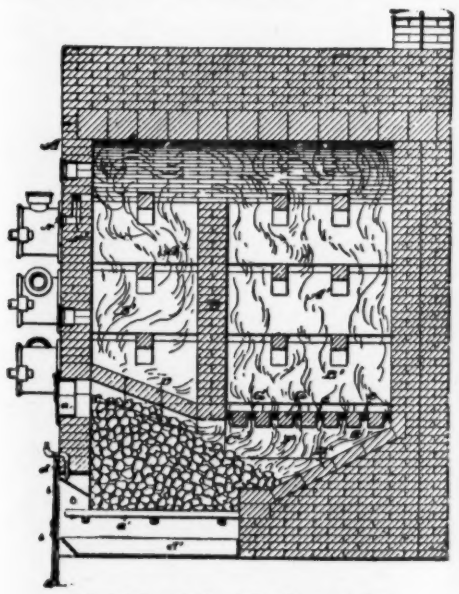

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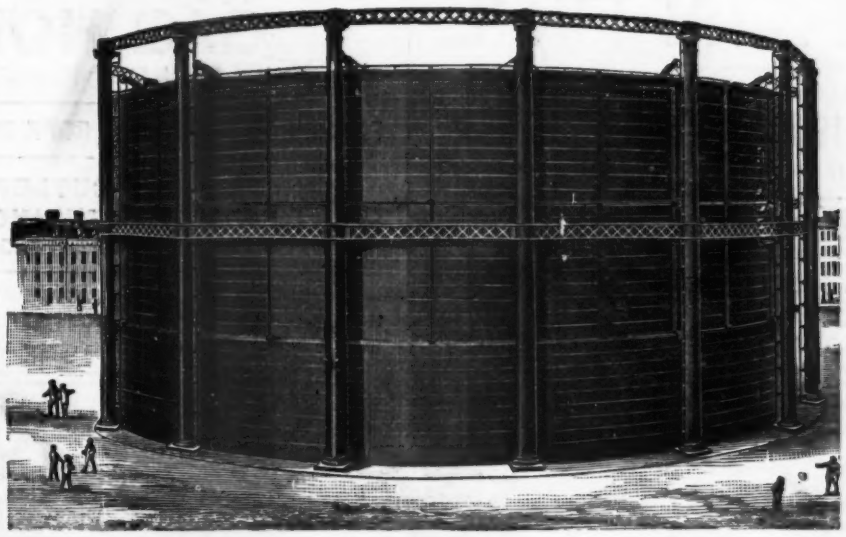

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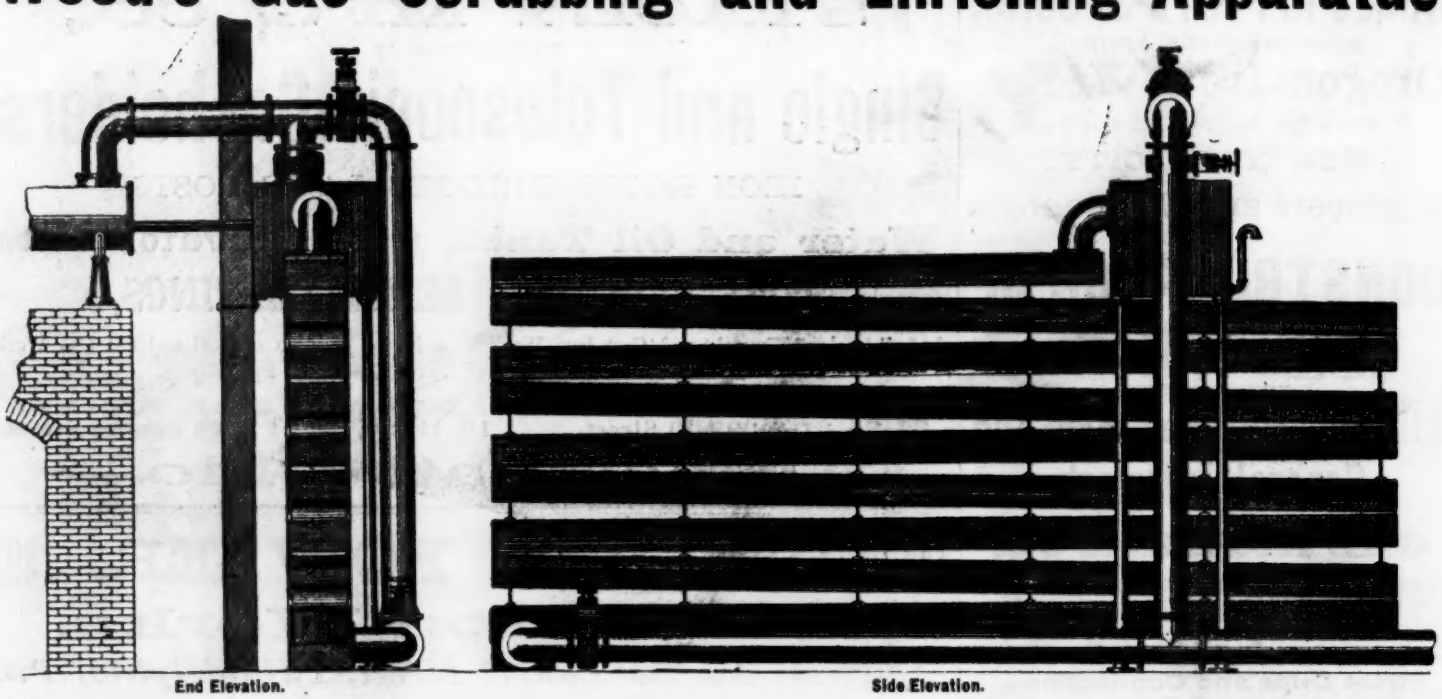

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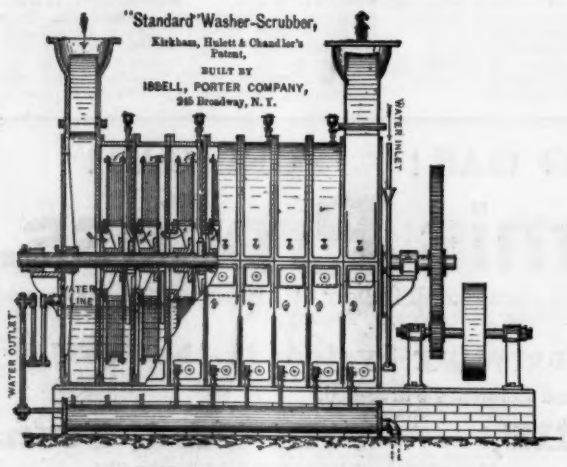

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For the Year 1892.

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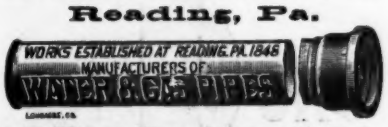

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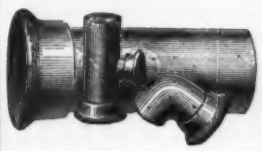

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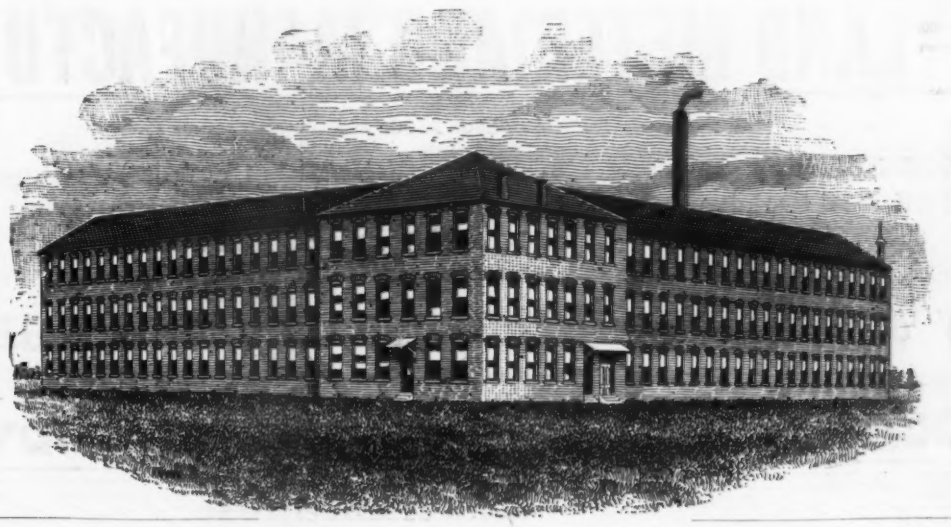

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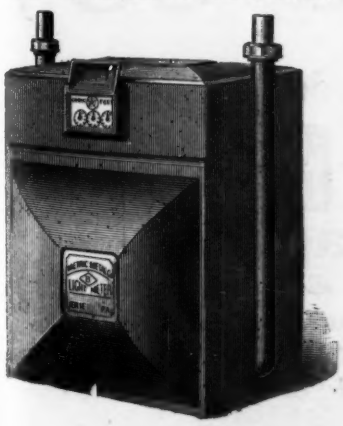

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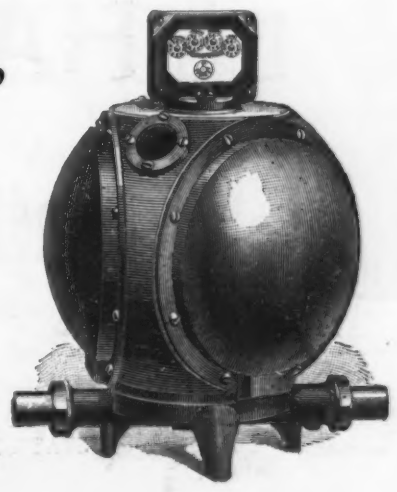

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